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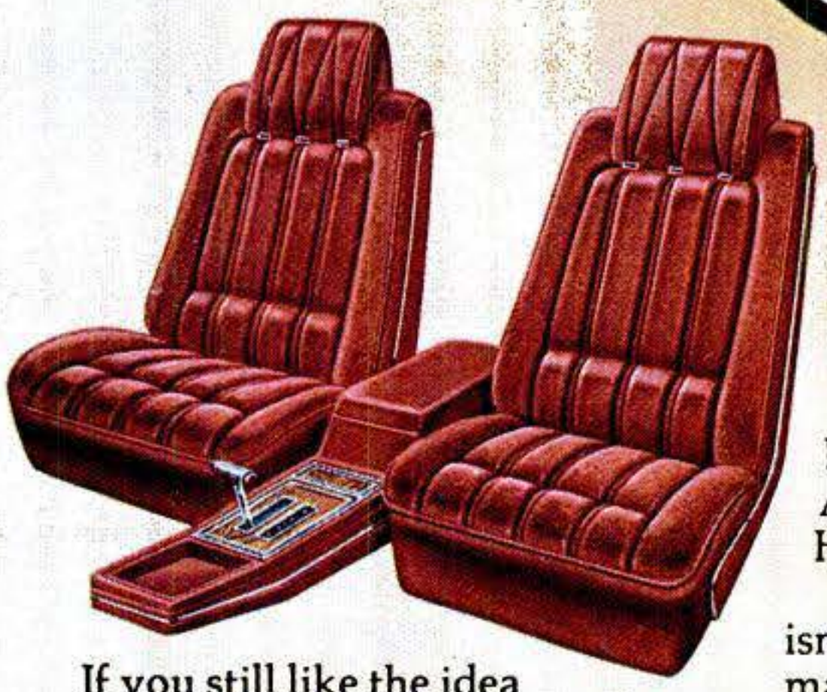
Announcing the Holiday 88.

Oldsmobile's new idea in sport coupes.



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Popular Science MONTHLY®

The What's New magazine

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PS READERS TALK BACK

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Getting out the ashes

The "Wood Stove You Can Weld" [Jan.] is a well-made stove, but what do you do when the ashes collect?

I have never seen a wood stove in my many years of using one that didn't have a door where the ashes could be scooped out. Imagine trying to get rid of the ashes with the fire smouldering in the stove and the smoke rolling out the top.

I think you had better design a side door at the bottom with an airtight seal.

Celey Baum, Farmington, Utah

To keep construction simple and the cost low, an ash-removal feature was not included. Airtight door and hinge assemblies are relatively difficult to fabricate. As it is, the stove is large enough so that ashes need be removed only occasionally. This is accomplished by letting the fire die out and removing the ashes with a shop vac.

Tile stoves—best wood burners

Jason Schneider's excellent article, "The Secrets of a Good Wood Stove," [Nov. '77] has come up with convincing arguments and a very clear explanation of how wood stoves operate. His discussion of the problems of wood stoves is also excellent. But he does not mention the solution, the kind of wood stove that is free of all of these problems: the Central European Tile Stove. The tile stove is superior to cast-iron and sheet-metal stoves by being more efficient, safe, and attractive.

Its superior efficiency comes from two basic characteristics of its operation. First, the combustion is hot and fast. At 1000°-1200° F nearly all the gases are turned into heat, and very little smoke, creosote, or ash are left over. The burning hot gases travel a long way through labryrinthine passages, exposing the heat to a great amount of surface. The great mass of the stove thus stores the heat.

The second principle is that coals in an ash bank feed on themselves. They need to remain in intense heat to generate efficient additional heat. In a tile stove this heat is stored by the time the fire burns down to embers and the airtight door is closed. This is the time when secondary heat generation starts, with practically no air needed. This has an added advantage: No cold air is drawn into the house and no warm air is vented out through the flue. The safety of these stoves comes from the fact that their outside never gets too hot. One can touch them and lean against them. They do not need clearance from combustible walls.

Finally, during the main part of the heating cycle, some nine to 11 hours, there is no fire. With the door completely closed, no sparks can ecsape.

It would not be fair to omit the disadvantages of the tile stoves. To me, the greatest is its price. The tile stove is not mass-produced; it is built by master craftsmen and this makes them very, very expensive. Also, they are very heavy. And finally, the heat output cannot be regulated. But for those who value craftsmanship, who want something different and beautiful, and are willing to pay for it, the tile stove will bring long-lasting satisfaction.

Edmund I. Lazar, Bethesda, Md.

Corncob stove

While wood is available in my area, I have another source of fuel that's actually free. I'm in the seed-corn business, and have access to several tons of dried corncobs each fall. I have seen how intense a cob fire can be, and I would like to know if I could use cobs in a stove attached to my central-air furnace. Would a wood stove work or would I have to design a different stove of some kind? I hate to see all that fuel going to waste.

Steve Kinsell, Remington, Ind.

Jason Schneider replies: "Dried corncobs are a perfectly satisfactory, relatively nonpolluting fuel, and stoves designed for corncob burning were produced and sold in the mid- and late-

[Continued on page 164]

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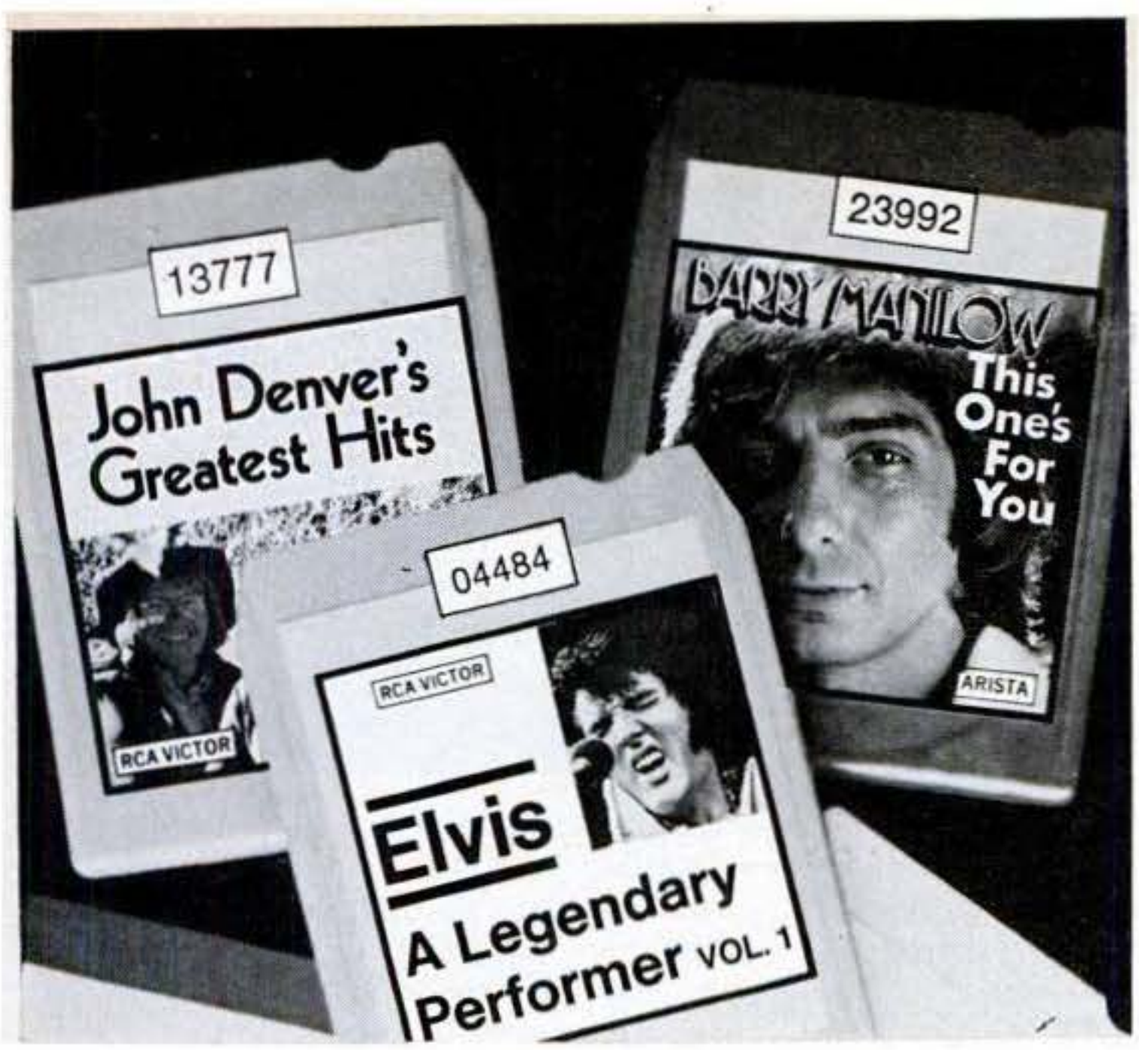

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CALCU-LETTER

By DARRELL HUFF News of pocket calculators—and how to have fun with them

Watering your guests

Imagine yourself owner of a summer hotel that has its own water supply, a spring that flows into a large reservoir. You know from experience that you can handle 770 guests for 24 days, or 330 for 60 days, before running out of water.

Since the longer period permitted more guest-days and more income, you plan to stretch the season further this year. You decide to stay open 121 days. How many guests can you keep watered for that long?

You may feel that this problem shares one characteristic of many of the best puzzles: There doesn't seem to be quite enough information to permit a solution.

Where are you?

For a little brain exercise, consider this classic problem to which that last observation applies. Startled by a bear, an explorer runs a mile due south, then turns to his right, and runs another mile west. Then he makes another right turn and runs a mile north. To his astonishment, he then sees the bear again and discovers that he has returned exactly to his starting point. What color is the bear?

If you're not familiar with the problem, by all means stop now and give it a try.

If you are, you'll recall that the bear was white—because only polar bears live where all directions are south. That is, at the North Pole.

That was the accepted answer for a long time, but recently it has been noted that mathematically—if you leave out the bear—there are other answers.

That is, there are other places on our globe from which you can go due south for a mile, west for a mile, north for a mile—and be right back where you started. Honestly.

I'll leave this for you to chew on till the next (May) installment of this column. The answer will be up for discussion then, along with the solution to the problem of the hotel guests and their drinking habits.

Ladies' ages

An item of business pending since our last meeting has to do with the courtly gentleman who refused to reveal the ages of three women. He would say only that the product of their ages was 1296 and the sum was the same as the number on my house, though he did tell me his age and admit to being older than any of them. Only after learning this last piece of information was I able to announce that now I could produce the three ages. Knowing the product of the ladies' ages —but not my house number or the gentleman's age—can you do the same?

It turns out that this is a truly sterling example of what we mentioned earlier: a puzzle seemingly lacking essential information.

But despair not! If you have not already done so, get out your calculator to speed the task and list all the groups of three numbers whose product is 1296. Beside each trio, put its sum. There will be 42 of these rows, beginning 1, 1, 1296 (1298); 1, 2, 648 (651); 1, 3, 432 (436); and ending with 9, 12, 12 (33).

You would think that I, knowing my own house number, would need only to locate it in the fourth column and find the three ages beside it. That I had been unable to find the answer this way indicates that my number must be the one—the only one—that appears twice.

This piece of logic tells you what I already knew—that the number of my house is 91 and the ages are either 1, 18, and 72 or 2, 8, and 81. Since I was able to discriminate between these trios, the age the gentleman whispered when saying he was older than any of them must have been above 72 but below 81. That being the case, the only set of ages that qualifies is 1, 18, 72.

Testing for accuracy

Though you'd never discover it while working with such numbers as those, even the best of pocket calculators is not absolutely accurate on every computation. And some are more accurate than others.

In making a choice for purchase (or just for fun if you have two or more calculators around), try some reciprocating problems. I find, for example, that if I treat my phone number as a whole number and decimal, multiplying and then dividing it by 3.3333333, what started as .8052 comes out .80519. When I combine the square-root operation on another calculator with squaring and multiply-divide sequence, it comes out .80517.

Thin as a pen

Most of the time, however, the important thing about a calculator is not that it be accurate beyond the fourth decimal place, but that it be at hand when wanted. That's what the one shown above is all about.

The inch-wide DataClip from Texas Instruments is as thin as a ballpoint pen and about as long. And it's one of the new breed of calculators that seems to go on forever—1000 hours on a set of batteries, compared with as little as three hours only a couple of years ago. There's no need for recharging or AC adapters. TI suggests a price of about $35.

Truck-in-the-tunnel problem

Offered in our January installment was the case of two boys who chose to come from track practice by way of a dangerous tunnel. When they were 37 percent of the way through the tunnel, they heard a truck coming. Immediately running in opposite directions at a known speed (they could do the hundred-yard dash in 12 seconds), each barely escaped. Question: Was the truck exceeding the maximum legal 55-mph speed limit?

As you may have discovered, a solution can be reached by setting up some time-equals-distance-times-velocity equations. But I like this shortcut approach:

Since one boy has run 37 percent of the length of the tunnel before the truck entered it, the other must also have done so. This leaves him 26 percent (100 percent minus twice 37 percent) of the distance to cover while the truck is going the whole way, so his speed must be 26 percent of the truck's. Converting 100 yards in 12 seconds to miles per hour and dividing by 0.26, your calculator tells you the truck was doing about 65 mph, barreling—illegally—through the narrow tunnel.

If you have trouble arriving at a calculator routine for converting a 12-second hundred into mph, try this: Multiply the number of seconds in an hour (60x60) by the number of yards (100) and then divide by the number of seconds (12) and by the number of yards in a mile (1760).

Note that if you do the dividing before the multiplying, some dropping or rounding off will occur—and you'll come out with a slightly different answer. PS

PS calculator columnist Darrell Huff (P.O. Box AS, Carmel, Calif. 93921) is the author of *How to Lie with Statistics, How to Take a Chance,* and other works. He welcomes comments, solutions, and suggestions.

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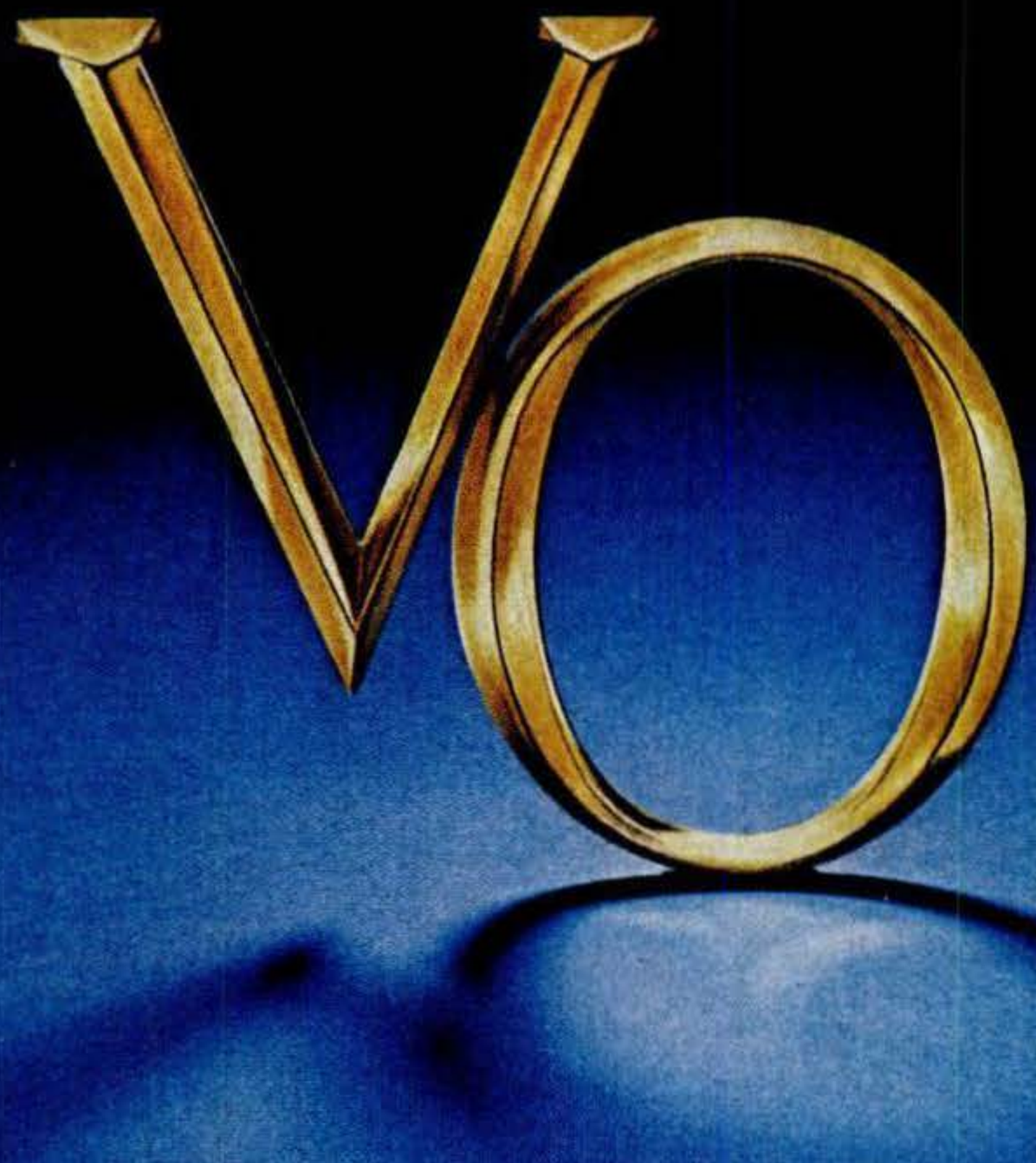

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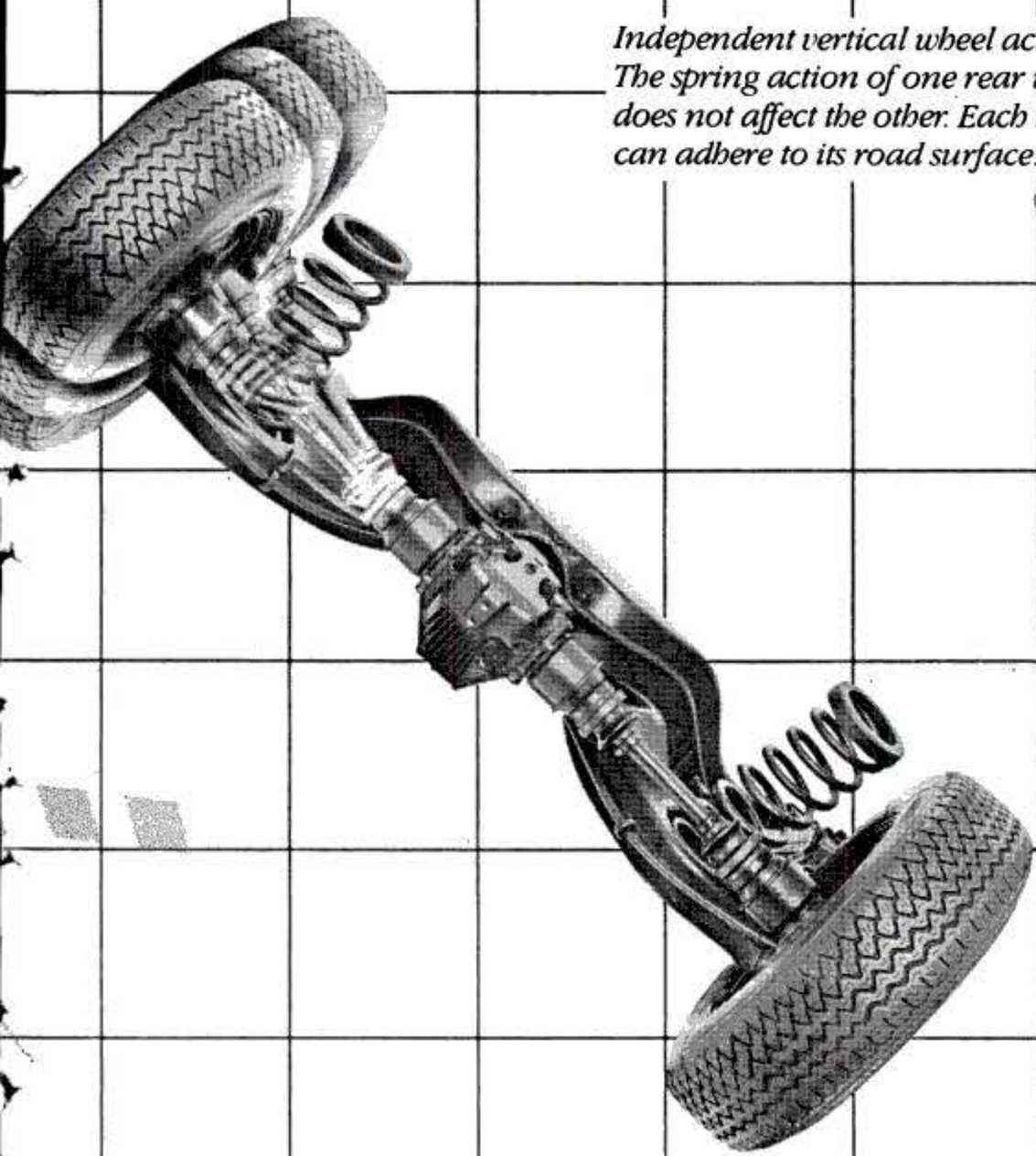
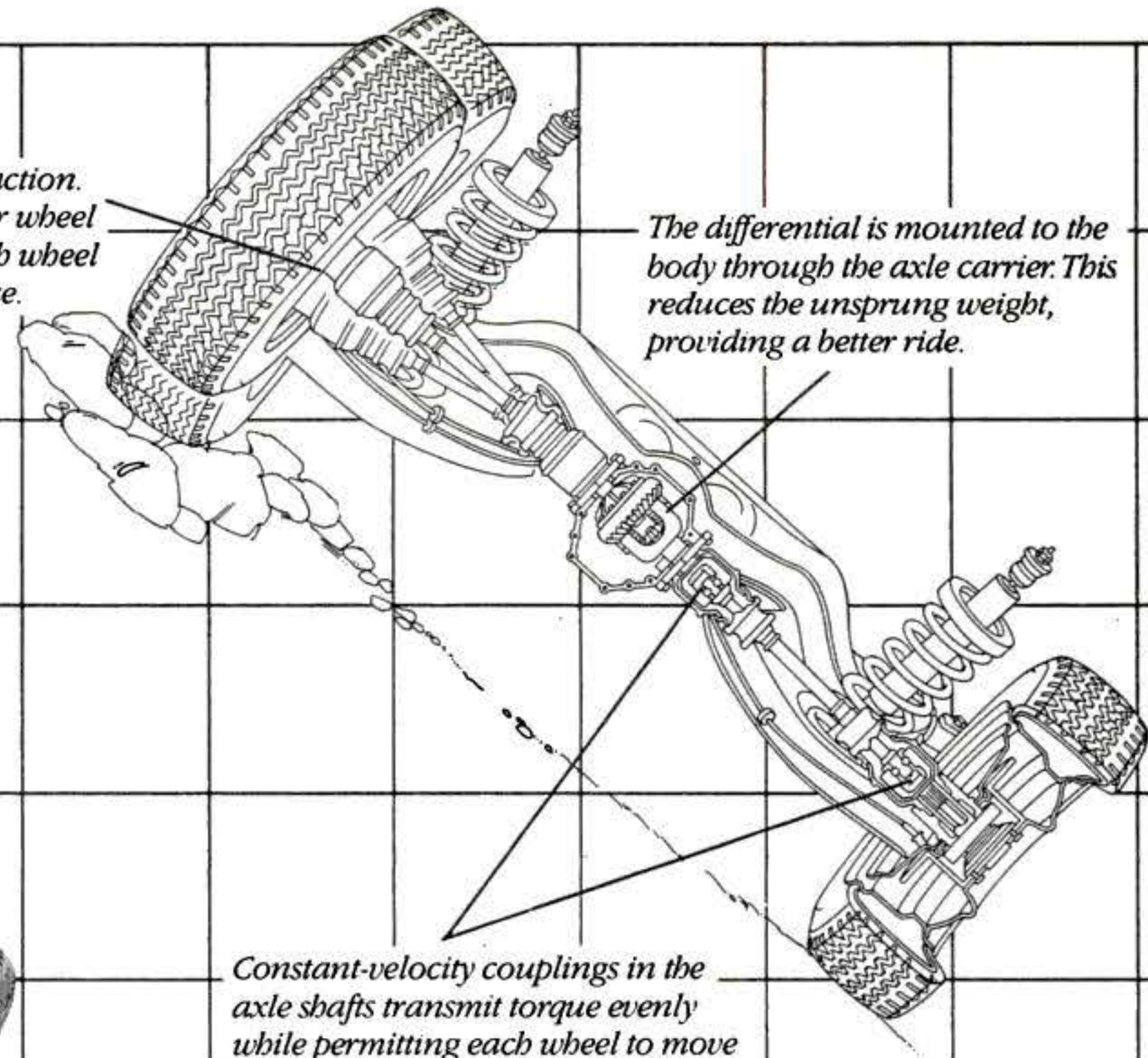
Why a Mercedes-Benz doesn't lose its dignity on sharp curves, in panic stops or on washboard roads.





© Mercedes-Benz 1977

In 1931 Mercedes-Benz engineers launched a new era of driving comfort, performance and safety by introducing 4-wheel independent suspension. For the next 46 years they continued to modify and improve this revolutionary concept in the quest of perfection. Their achievements are reflected in the new Mercedes-Benz automobiles of today.

Surer grip of the road

Four-wheel independent suspension put the automobile on the road to greater safety.

For the first time *every* wheel of a passenger car could adapt to rough road surfaces without losing a sure grip.

And since the wheels acted *independently*, if one encountered a soft shoulder or pothole, the remaining three wheels could handle the annoyance with greater safety than was ever before possible.

Handle bumps without jostle

In 1954 Mercedes-Benz introduced single-joint swing axles to passenger cars. This gave the driver a surer feel of the road. It also let a Mercedes-Benz step nimbly, up and over brutal bumps and around tight curves with much less transmitted vibration.

In 1961 air suspension with automatic level adjustment was engineered into the 300 SE sedans. It eliminated even more vibration and added an even smoother ride. In 1968 diagonal-pivot swing rear axles with four constant-velocity couplings were designed in to keep that smooth ride constant.

Then in 1972 Mercedes-Benz introduced zero-offset steering on the front suspension of the 450 Series sedans. This helped straight-line tracking under heavy braking conditions and provided more precise steering control in emergencies like blowouts.

The suspension of the future

It's the ingeniously engineered hydro-pneumatic suspension on all four wheels of the Mercedes-Benz 6.9. It gives the driver a level of control almost unmatched by any other 4-door sedan. It provides exceptional stability, even on curves or dirt roads laced with potholes.

Why does Mercedes-Benz go to all this trouble just to keep four wheels on the road? Simple: The engineers believe their job is to advance the state of the automotive art.

They continually strive to find better ways to make a Mercedes-Benz even easier to drive. So the driver has more time to keep his mind on the road ahead. Fatigue is reduced by blessing him with an *absence* of vibration, bouncing, swaying and undue noise.

Safety first

All cars surround you with safety belts. A Mercedes-Benz also surrounds you with an additional belt of safety: a unitized steel protected passenger shell which is designed to help absorb impact energy.

In an unavoidable accident situation a Mercedes-Benz is designed to crumple progressively. For example—on impact the forward subframe can absorb shock by gradually closing like a metal accordion.

All in all a Mercedes-Benz surrounds you with over 100 safety features—most of which you'll probably never notice or need. But they're there—just in case.

Engineered like no other car in the world

People give many reasons for choosing a Mercedes-Benz.

But the company's aim in designing and constructing them is doggedly single-minded.

It is to build safe, comfortable, practical cars—with as few imperfections as possible.

This philosophy puts engineering ahead of petty economies and precludes the mass production of inexpensive cars.

It allows little room for compromise or for shortcuts; just the pursuit of engineering excellence.

A Mercedes-Benz is engineered like no other car in the world.

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SCIENCE NEWSFRONT

By ARTHUR FISHER

Explosive progress

The combination of explosives and glasses might not seem, at first, to be a happy one. But researchers at Lawrence Livermore Laboratory have come up with a way to fashion useful forms of materials called metallic glasses—hitherto laboratory freaks only—by blasting them with explosive chemicals.

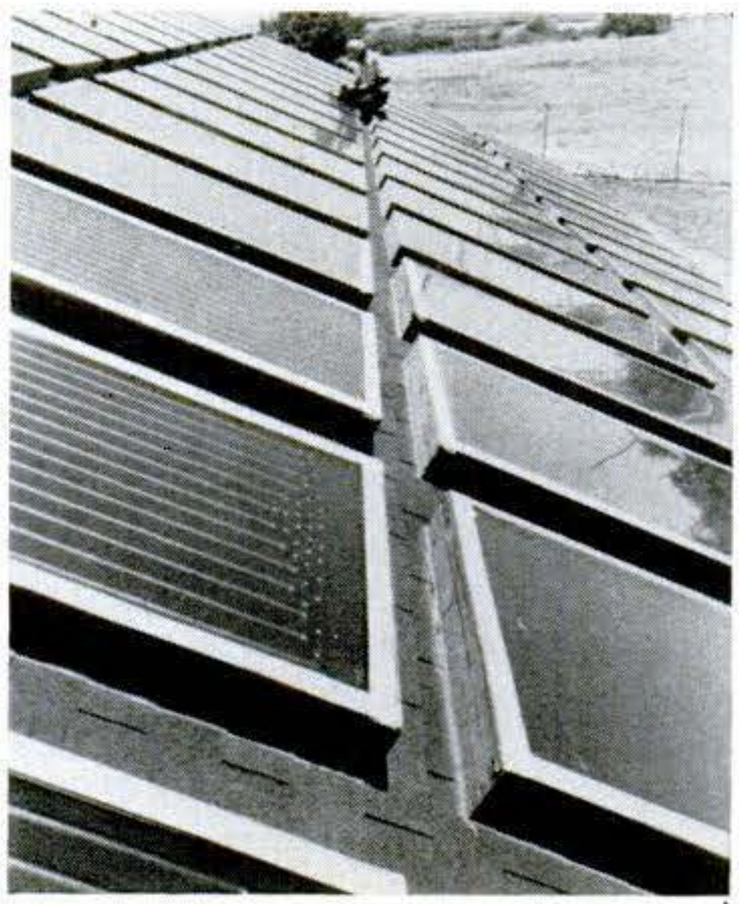
Metallic glasses are so called because their atomic structure is random, as in amorphous materials such as glass, rather than ordered, as in crystalline metals. They are actually complex metal alloys forged by cooling liquid mixtures of at least three different metals so fast—millions of degrees per second—that the metal atoms have no time to get organized. This gives them bizarre and useful properties, such as resistance to radiation and corrosion. And that would make them ideal materials for structural members in nuclear reactors, pipes carrying corrosive chemicals, and wear-resistant bearings.

The problem is that they have been previously formed only as powders, wires, and ribbons, forms not famous for structural strength. The reason: the high temperatures required for conventional casting and welding into more useful shapes also destroyed the materials' useful properties by reordering their atomic structure.

Now, however, a group at LLL headed by Carl Cline has developed techniques that evade the temperature problem by using controlled explosives. These can suddenly squeeze metallic glass powder into a solid bar or weld a metallic glass ribbon to a piece of steel (shown in the photo above, right, in which the white strip—a nickel-iron-boron-metallic glass—is bonded flawlessly to a steel plate—the speckled, because crystalline, area below). At left, an LLL technician spoons powdered metallic glass into a tube. The cylindrical display at the right in this photo simulates an explosive-compaction apparatus.

Liquids for solar collectors

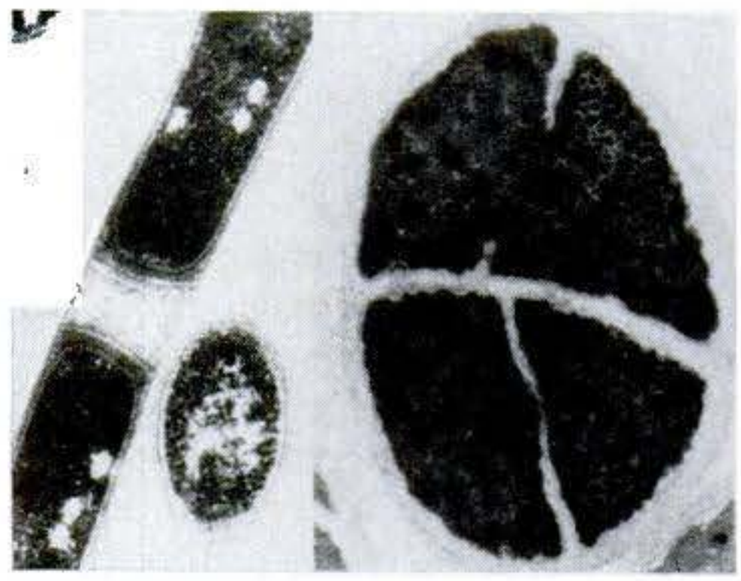
What kind of heat-transport medium will prove most efficient in solar collectors? In the photo below you can see an ongoing experiment to develop some answers. NASA-Marshall Space Flight Center has asked PPG Industries' technical center in Corpus Christi, Texas, to test 14 different antifreeze-type liquids in 64 separate flat-plate solar collectors. The liquids, which transfer heat from the sun's rays to a structure's water heater, and heating and cooling systems, are being evaluated for their heat-transfer properties, freezing and boiling points, corrosive action, and resistance to chemical degradation. Three different metals—steel, copper, and aluminum—are also being tested as materials for the collectors themselves.



More on oldest Earth life

In January I wrote about some recent discoveries that may help elucidate the origin and evolution of life on Earth—and perhaps in the solar system. Now comes another provocative claim—that a methane-producing organism, once thought to be an ordinary member of the family of anaerobic bacteria, may actually represent the oldest form of life on Earth.

The one-celled creatures, shown here, are called Methanobacteria thermautrophica, and have been found only in such oxygen-free environments as the deep hot springs of Yellowstone Park. A research team headed by Dr. Carl R. Woese, of the University of Illinois, speculates that these organisms are relics of a primitive life form that evolved before Earth was even a billion years old, an evolutionary line preceding and separate from the other bacteria. Their theory is based on an analysis of one component of the organisms' genetic apparatus, ribosomal RNA, which has frequently been used to identify a life form's place in the evolutionary scheme.



The possibly ancient methane-producing bacterium gets its food and energy from simple compounds such as carbon dioxide and hydrogen, probably abundant in Earth's primitive atmosphere. It does not use gaseous oxygen—nonexistent on Earth four billion years ago—nor such complex compounds as sugars and amino acids.

Lixiscope

The picture on the following page shows the Lixiscope—short for Low Intensity X-ray Imaging Scope—with its inventor, Dr. Lo I Yin, an X-ray researcher at NASA's Goddard Space Flight Center, Greenbelt, Md. The photo also shows some examples of the kinds of images it can produce: teeth, the in-

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And, yes, lower 'tar' than Winston or Marlboro.

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VICEROY 16 MGS. 'TAR,' WINSTON 19 MGS. 'TAR,' MARLBORO 17 MGS. 'TAR,' AVERAGE PER CIGARETTE, FTC REPORT, AUG., 1977

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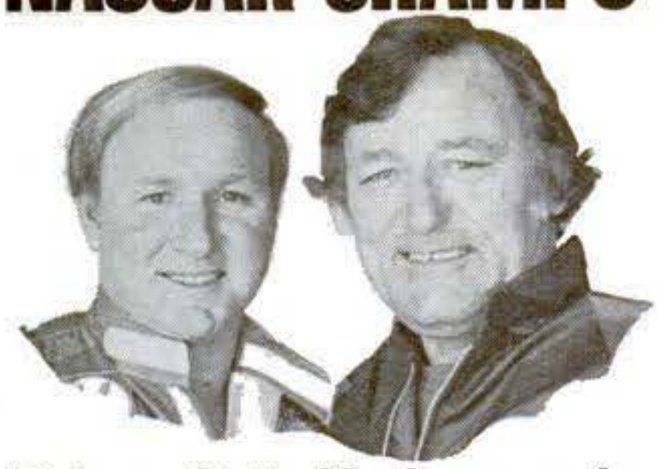

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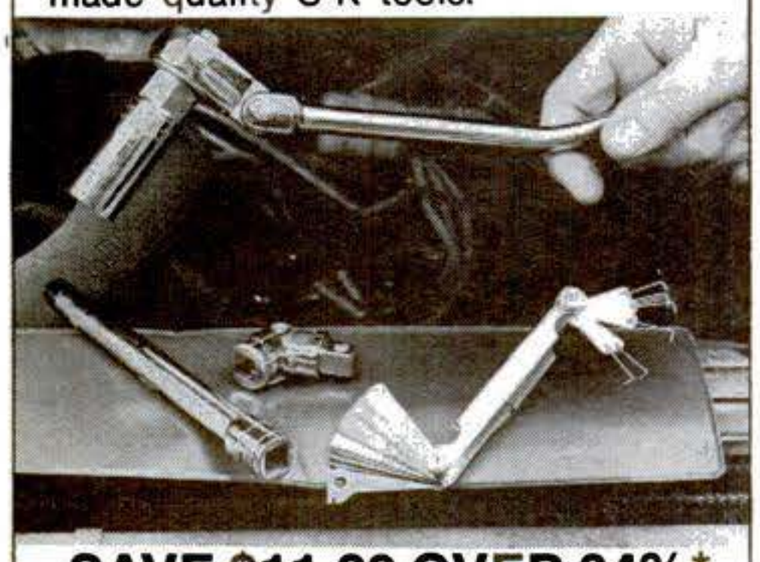

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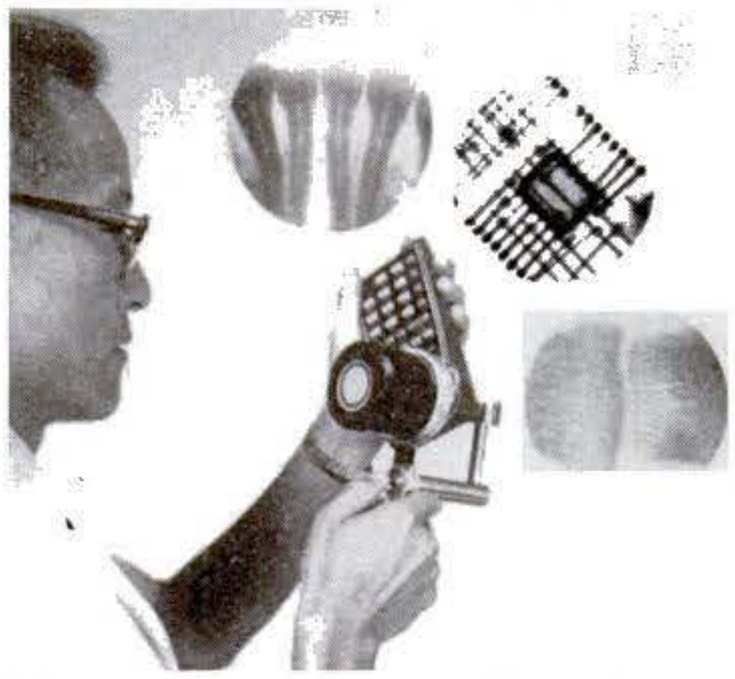
[*Continued*]

nards of a calculator, a finger joint. And all from a small, hand-held device powered by a single penlight battery. The Lixiscope uses a recently declassified night-vision image intensifier, a small amount of radioactive material, and an X-ray phosphor screen. Instant pictures of X-rayed objects can be made using a radioactive exposure a thousand times



weaker than with a conventional X-ray machine. Obvious applications: dental screening, detection of sports injuries on the field, gas leaks in pipes . . . you name it.

Himalayan quake due?

Two scientists with the Cooperative Institute for Research in Environmental Sciences (CIRES) have pinpointed an area in northeastern India along the southern rim of the Himalayas that may be due for a major earthquake. Drs. K. Khattri and Max Wyss of CIRES (a joint project of the University of Colorado and the National Oceanic and Atmospheric Administration) base their prediction on a curious pattern of seismic activity they have uncovered in the zone, where some of the world's most violent quakes have occurred. They found that every major quake (more than 6.6 in magnitude) had been preceded by a period of seismic silence—a seismic gap. And they found the suspect area along the Himalayas to have been ominously quiet for a time long enough to constitute just such a seismic gap.

Amorphous solar cell

RCA has announced that one of its physicists has received a basic U.S. patent for a device the company believes will play a major role in future energy technology. Dr. David E. Carlson, head of Photovoltaic Device Development in the RCA Energy Systems Research Laboratory, was granted the patent for "a semiconductor device having a body of amorphous silicon." Photovoltaic solar cells made of such materials, RCA believes, may produce electricity at costs competitive with a variety of conventional sources sometime in the 1980's.

Crystalline silicon solar cells have higher efficiencies, but are expensive, difficult to "grow," and limited in size. They require processing temperatures of more than 1100° C contrasted with 300° C for the amorphous (random atomic structure) material.

In the photo below, Dr. Carlson is operating a glow-discharge apparatus used to make cells of hydrogenated amorphous silicon. Silane gas, consisting of hydrogen and silicon atoms, is processed in a low-pressure glow-discharge chamber. (Fluorescent lamps use a kind of glow discharge.) The result is a thin layer of the hydrogenated amorphous silicon deposited over whatever substrate is placed in the chamber. PS

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"SAY, SMOKEY—"

A clinic on cars by Smokey Yunick, America's most famous mechanic

Wants to burn cheaper gas

I have a 1969 Chrysler New Yorker with a 440 engine and four-barrel carb. The manual calls for premium gas with 95 or higher octane. If I use lower octane, the engine pings. Premium gas is getting more difficult to find all the time and I have thought about adjusting the engine to use regular. The specs call for 7½ degrees timing advance. Some mechanics have told me an adjustment to retard the spark four degrees is all it takes. I realize this might decrease the pickup but I'm not concerned about this as long as I have a smooth-running engine that won't be harmed by the adjustment.

Louis L. Kolbl, Canton, Ohio

Biggest difference in engines requiring high-octane fuel is higher compression. If you retard timing, that helps by reducing the possibility of regular gas getting out of control. But it's a borderline thing. To find out what's right, try it. But be sure you can recognize detonation. The best way, I think, is to retard the timing, switch fuel, and drive off normally. Let it get in high gear and lug it up to, say, 60 mph, and listen closely. If the engine doesn't knock, you probably can get by. If it's hilly where you live, accelerating up a hill will tell you real quick.

If it knocks, the ball game is over. You can't use this adjustment unless you reduce compression. Then, thicker head gaskets, bigger combustion chamber, lower-compression pistons (and so on) are called for.

Diesel questions

I have just ordered a VW Rabbit with a diesel engine. I can anticipate a situation where I will be almost out of fuel and the only fuel available will be gasoline. I know that many diesel parts depend on the diesel fuel for lubrication, such as the injector pump, which would be ruined if run with straight gasoline.

My question is, can you safely run the VW diesel on gasoline if you mix oil with it, and if so, what kind of oil and what proportion?

I would also like to know what you recommend for oil-change intervals and can the use of Mobil 1 extend these intervals by a large enough margin to be economical?

James R. Tidbeaux, Palmer Lake, Colo.

Don't put gasoline in a diesel. Gasoline burns faster and would be out of control in the very high diesel compression. I can't think of a better way to destroy a diesel engine.

Yes, if you're a petrochemist you can mix gasoline and oil and come up with an emergency batch of fuel. But it's not even worth considering in normal circumstances.

Diesels consume more oil than gasoline engines, so by the end of a long change interval you'd have added nearly your system's capacity in new oil. Today, it's fashionable under the heading of energy conservation to extend oil change intervals. But in real life the frequent oil-changers get more miles per dollar. I believe that oils should go to a secondary use after three or four thousand miles in an automobile. Mobil 1 in a diesel? I don't know. Write them. My experience with Mobil 1 has been with gasoline engines, and that was pretty good. We work on many diesels, but none that use Mobil 1.

Read your owner's manual. It has the answer to best oil type.

Concerned about corrosion

I have to keep my car outside. At night, when it gets frosty, moisture condenses on the car. What can I do to protect the paintwork and metal from the ravages of the elements, especially dampness?

I try to give the car some protection by using a cloth cover that has been treated to make it water-resistant. It's fine in dry or sunny weather, but during rains or heavy fog moisture will seep right through the cloth.

How often should I wash the car? Since wax itself is an abrasive, won't more frequent waxings cause the paint to peel?

Luis Cabrera, Salinas, Calif.

Oxidation and water and temperature changes eventually destroy paint-plastic platings. No way out. High humidity and heavy rain just can't be held off forever. Fortunately, paint coats have gotten better in recent years.

Car covers have too many different problems to be depended on for the long haul in all climates.

The only practical solution is frequent washing and reapplication of a cleaner and sealer wax. Weekly or biweekly washing is the greatest life extender.

Low-brake-pedal problem

I have a 1977 Ford LTD with 7500 miles that has had a soft brake pedal since it was new. In a normal stop, I have ¾-to-one-inch pedal travel, after which I can easily push the pedal another inch and it never feels solid. The car has been to the dealer three times for this. The first two times they said they bled and adjusted the brakes—which helped for about a week. The third time, I talked with the desk man and two mechanics who said they could find no trouble and that "some cars are like that."

What do you think? Is my car okay, or am I getting a lot of hot air?

P.T. Good, Livonia, Michigan

You don't say whether you have power or manual brakes. Power brakes have a spongy feeling because you don't push that hard, and the pedal is actually just a trigger. Vacuum is applying force to the master cylinder.

Anyhow, air in the system or incorrect adjustment accounts for 90 percent of low- or spongy-pedal problems. Air can be trapped in a high part of the hydraulic system and be very hard to get out. Usually, reducing bleeding pressure to nearly nothing and repeating the process three or four times with a ten-to-15-minute wait between bleedings will work the air out.

Disk brakes sometimes require removing the caliper and bleeding with the bleeder in an upright position. Also, if a disk pad retracts too far, say from excessive rotor runout, that gives a low pedal.

Considering a new car

I drive a '66 Dodge Coronet which has rolled over 118,000 miles and is showing its age. I am considering a new car.

How about a limited-slip differential? One consumer organization doesn't recommend it; they claim that on a low-traction surface such as ice or loose gravel both wheels may spin and cause the car to slide sideways. But isn't this also possible with an ordinary rear end when the surface under both wheels is equally poor?

I suspect that a limited-slip differential might be much more desirable with a lighter automobile. Is it a worthwhile option and should I order it if I buy a compact?

Andy Melnyk, Roslindale, Mass.

Limited-slip is not good for cars across the board. Most of these differentials need more maintenance and take more fuel. They require different driving techniques, some of which are hard to learn. But on a sub-standard surface they can be a big help.

Since you're talking about a new and maybe small car, look for front-engine, front-wheel drive—and I think you'll get what you're looking for. But these aren't star performers in a hard stop. I suggest you test-drive whatever you buy, since I can't think of any car that does everything. PS

Each month in *Popular Science* Smokey Yunick answers questions on cars—family cars, high-performance jobs, hot rods, and racing cars—selected from those sent in by readers. Got a problem? Send it to: "Say, Smokey—," Popular Science, 380 Madison Ave., New York 10017. Questions cannot be answered by mail.

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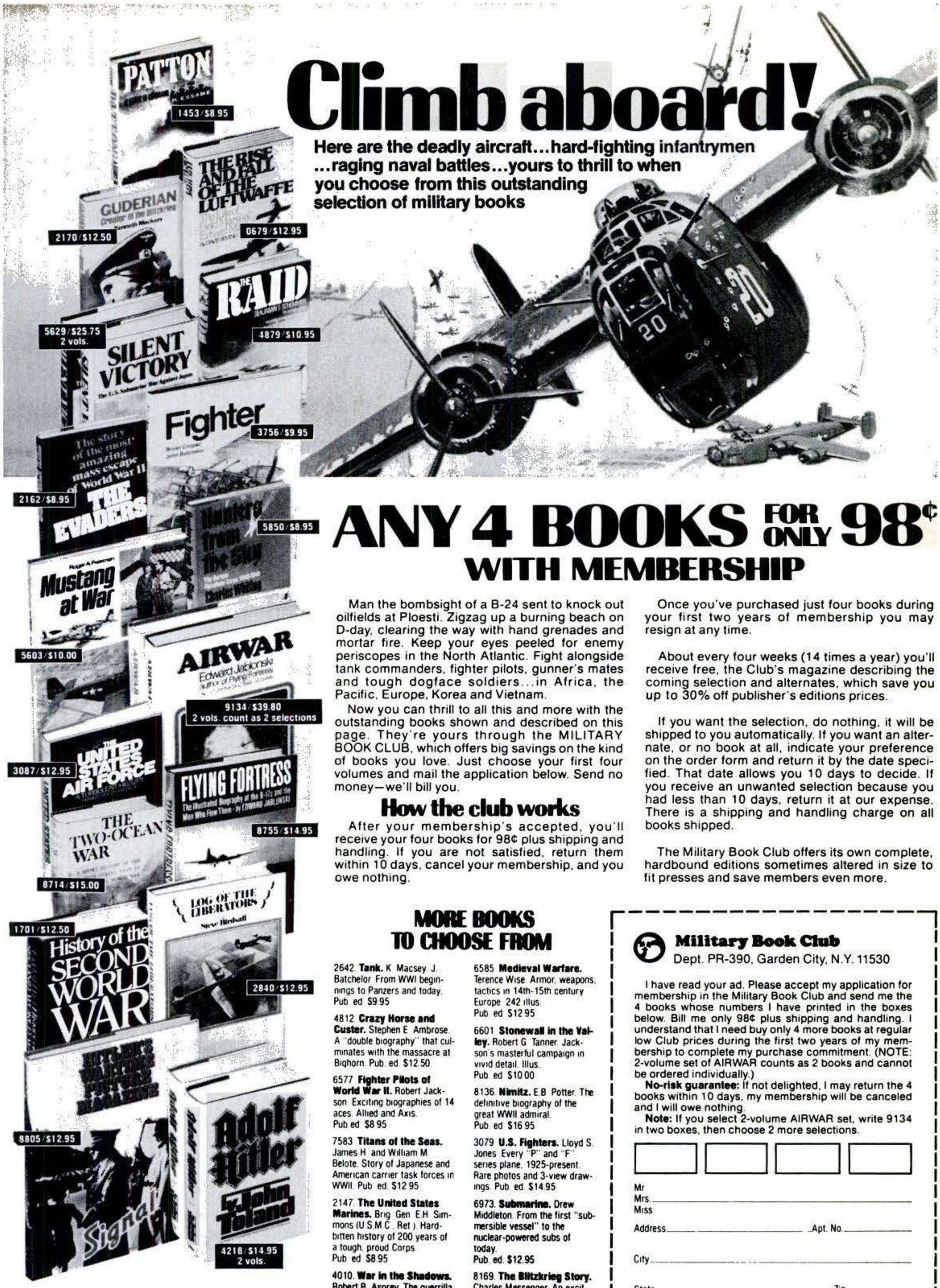

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RECREATION ROUNDUP

By HERBERT SHULDINER

Shape of things to come?

The wedge-shaped trailer behind the Fiat 126 (one of the world's smallest four-seaters) is the Fisher Bambino. The trailer, 7½ feet high and 11'3" long, weighs only 730 pounds. Despite its small size, however, the trailer has a double bunk and a galley. PS European Editor David Scott reports that the 25-hp Fiat 126 achieved an astonishing 33 mpg while towing the Bambino—but at a considerable price in performance. It couldn't exceed 50 mph with the extra load. The clever trailer design allows you to detach the camper body and use the chassis as a boat trailer. The dual-mode trailer is made by Fisher Holivan, Bridge St., Bagshot, Surrey GV195AT, England.

Would U.S. recreation vehicle buyers go for such a tiny rig? Not yet, in my opinion, but who can tell what skyrocketing fuel costs will eventually do to camping-vehicle trends in future years?

Van expanders

These clever tent add-ons can create extra sleeping space in any van, four-wheel-drive, or pickup camper with a cover—even a station wagon. The Nighty Nite is made by Foresight, Inc., Box 326, Cassopolis, Mich. 49031. It sets up in 10 minutes, claims the maker, and folds into a compact, easy-to-store package. Price is less than $300, complete with accessories.

Motor-home powerplants

Until now, Dodge has held a commanding share of the motor-home chassis business. The company claims about 75 percent of the market for both standard and mini-motor homes. Will all that change when Chrysler stops building engines over 360-cu.-in. after the '78 model year (see Detroit Report)?

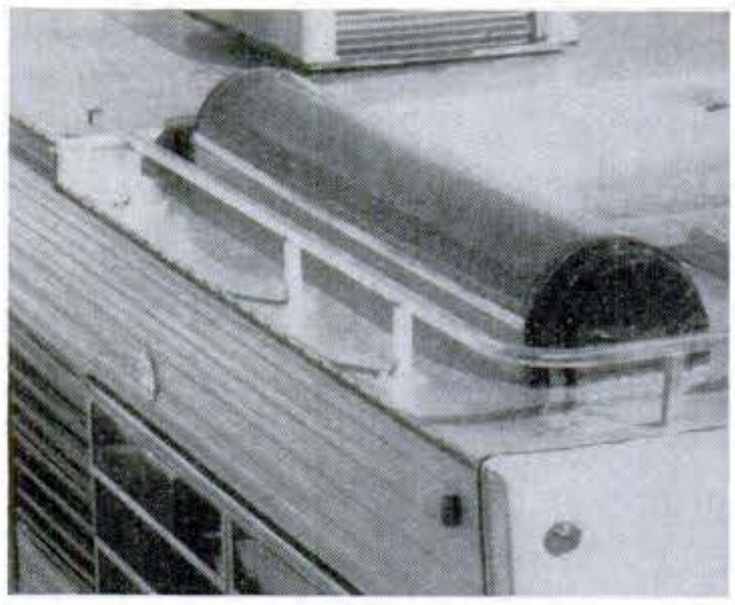
A product planner for Dodge's RV division told me that the company would continue to supply chassis with "adequate power." Whether RV makers would consider the 360 adequate for 25-foot mini-motor homes or 28-to-35-foot standard motor homes is problematical. Personally, I think a 360 wouldn't have enough power for a 35-footer.

I wouldn't be surprised to see a substantial shift to Chevrolet chassis for standard motor homes and minis. There could also be a shift toward Ford chassis for mini-motor homes. Chevrolet offers up to 454-cu.-in. mills in its motor-home chassis and Ford offers a 460-cu.-in. engine in a mini-motor home chassis.

Such a shift, however, might be only a short-lived solution to the motor-home builders' problems. Both Chevrolet and Ford will eventually phase out the big engines, as the realities of fuel economy affect their fleet averages.

Solar heater for RV's

A new wrinkle in motor-home gadgets is this six-by-12-foot solar collector now available as an option on Diamond mini-motor homes made by Coons Manufacturing, Inc. (Box 489, Oswego, Kan. 67356). The 25-pound unit collects infrared energy from the sun. A small electric fan runs air through the collector into the camper body. The heated air averages 110 to 115 degrees, says Bud Coons, president of the company. Coons reports that tests run by



his company show that the solar heater can reduce LP fuel use by camper owners from 40 to 50 percent annually. The unit does not store heat for nighttime use. The solar heater costs about $575, not including installation. It's available exclusively from Diamond RV dealers.

Separate vacations

Recently a Detroit couple left on an RV trip to the Southwest. The Detroit News reports that hubby drove the motor home while the wife was at the wheel of a small car being towed behind.

When he arrived at a motel parking lot in Toledo, he decided to pull in for a rest—and got the shock of his life. His wife and car weren't hitched to the motor home.

Somewhere along the way, the car had unhitched. While her husband drove onward, the wife blew the horn to no avail. She managed to steer the car off to the side of the road. She had an ignition key, but was afraid to drive a stick-shift car. So she stayed put rather than chase after her husband.

The couple was reunited when they called relatives who relayed messages between the two. The husband then drove back to hitch up again—and retrieve his wife. PS

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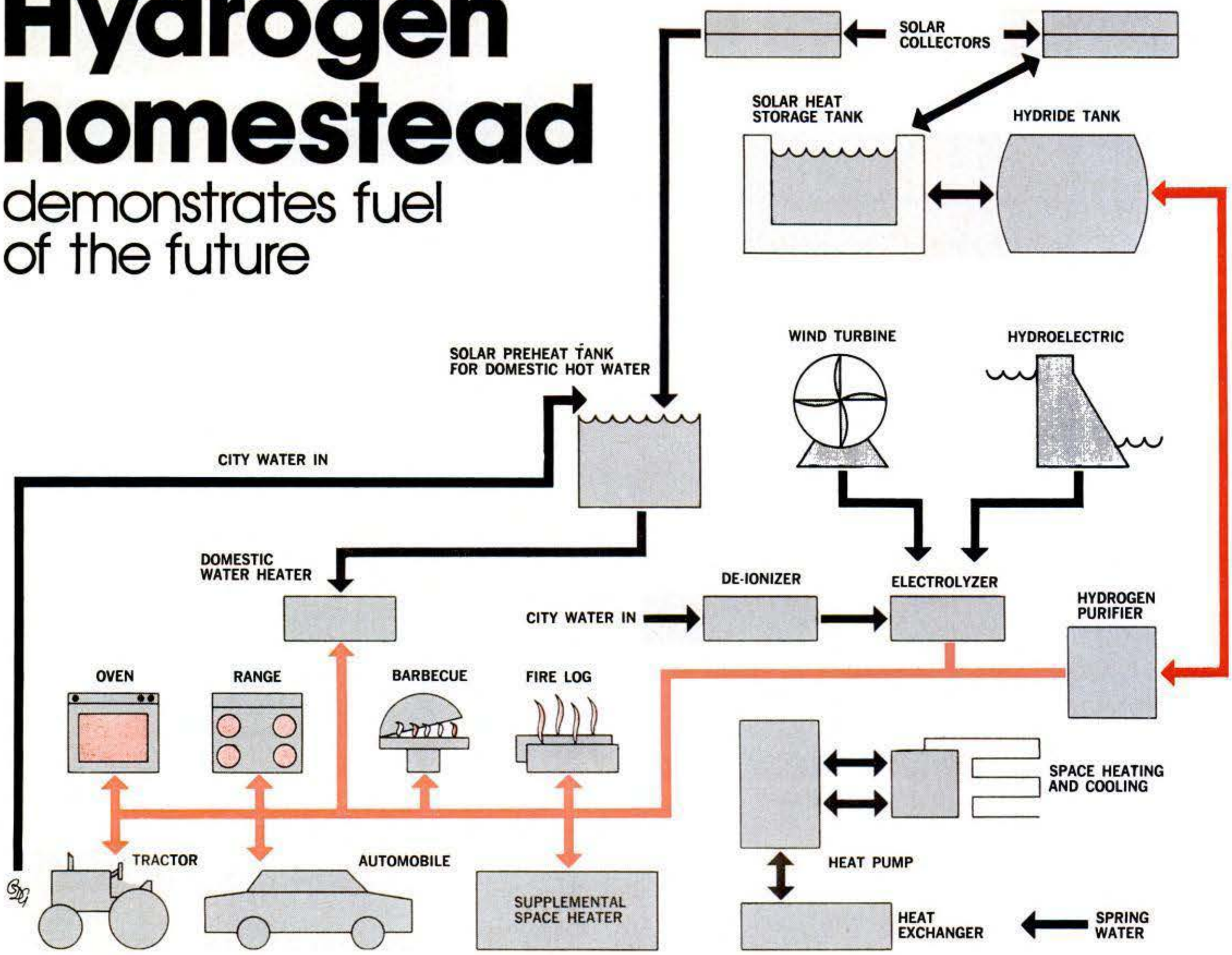
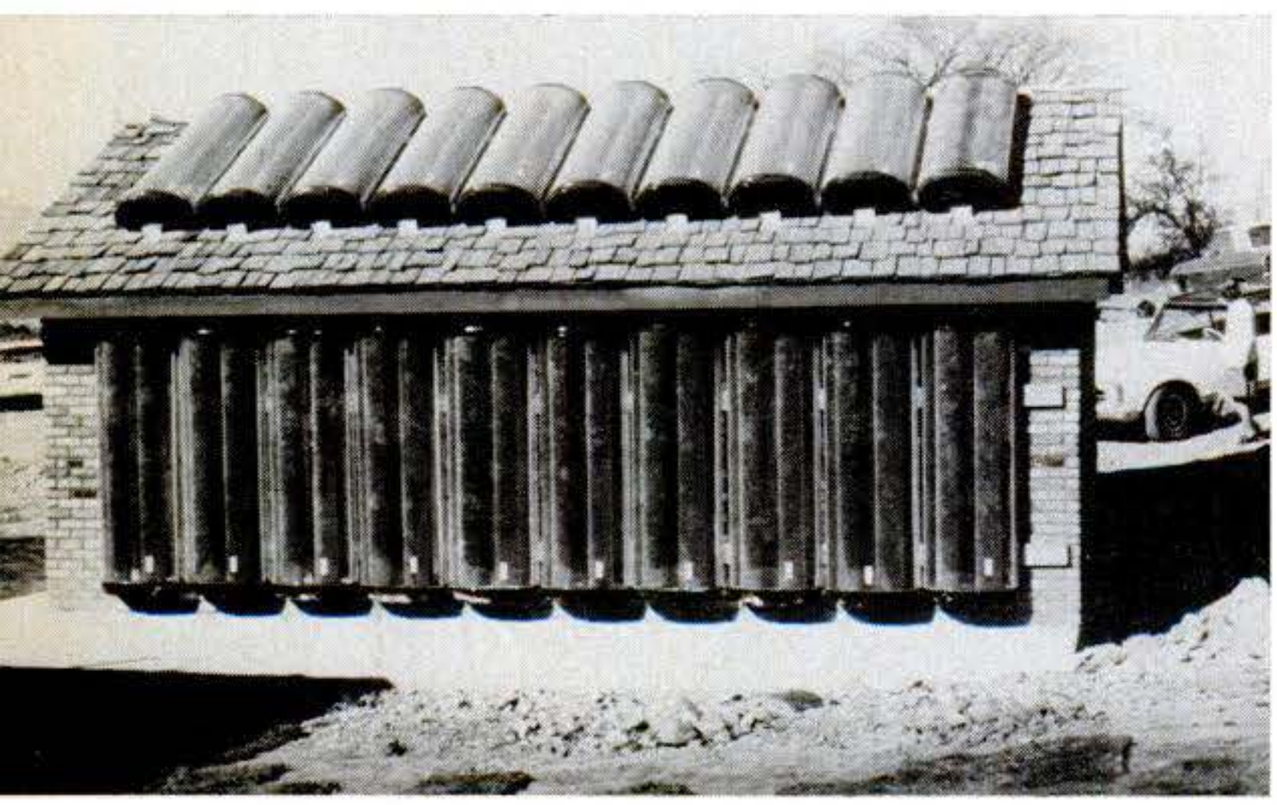
Hydrogen homestead

demonstrates fuel of the future



The Homestead's hydrogen is produced by an electrolyzer (drawing, far right). Present energy source is local utility; future plans call for wind turbine or small-scale hydroelectric plant. Hydrogen is stored in hydride tank (top). Heat from solar collectors liberates hydrogen as it's needed for use—cooking, charging hydride tanks in car and tractor, and water and space heating. A heat pump, which uses spring water as heat source in winter and heat dump in summer, provides most of home's space-conditioning requirements. "Hydro shack" (below), which houses electrolyzer and hydride tank, has solar collectors made by Solar Electric (403 S. Maple, West Branch, Ia. 52358) on roof and wall.



The most abundant element can cook your food, heat your house, and fuel your car

By RICHARD STEPLER

HINDENBURG LANE, PROVO, UTAH

From the street it looks like any other large contemporary house. In fact, it's so ordinary we're not showing you a photo of it. What *is* unusual about the house is that it's powered by hydrogen. And this house is just the first in what's planned to be a total hydrogen community.

In our March 1975 issue we described the "hydrogen economy" of the future ("Storable, Renewable Hydrogen Power"). In this scenario, hydrogen, generated from a variety of sources including the sun, wind, and tides, and hydroelectric, steam, and nuclear plants, would fuel vehicles, heat homes, power industry, and even provide a raw material for manufacturing synthetic products. This would be a clean society, as well: The only product of combustion of hydrogen with air is nonpolluting steam, provided that combustion temperature is not high enough to cause nitrogen in the air to form oxides of nitrogen.

One of the research organizations mentioned in that story, Billings Energy Corp., of Provo, Utah, was experimenting with hydrogen-powered cars. Since then

[Continued on page 25]

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Get Ready

There are hundreds of new micro-electronic products about to enter the consumer market. Here is how readers of Popular Science can discover them.

If you thought the pocket calculator started a revolution in 1971, just wait.

In the next twelve months more micro-electronic products will be introduced to the consumer than in any other phase of the micro-electronic revolution. Many of these products will 1) come from companies you've never heard of, 2) represent breakthroughs in micro-electronic technology, and 3) provide more conveniences and benefits than ever dreamed possible.

JS&A has been the company most sought after to introduce these new products. Our national advertising campaigns and our system of selling directly to the consumer give high technology companies the opportunity to introduce new products to the marketplace in the most economical, quickest and most efficient manner.

This article, written for readers of *Popular Science,* will tell you how we select products at JS&A. It will give you tips on how you can evaluate a new product, and it will give you an insight into how you can keep abreast of all new and important product developments.

AN INDUSTRY LEADER

Our role in micro-electronic marketing is a matter of record. We introduced the first pocket calculator, and we were largely responsible for creating a new industry. We were the first company to nationally introduce the LCD digital watch, and we are at the forefront of every major new product introduction including a few you will see in this issue.

To achieve these results, we have concentrated our efforts on doing only one thing and doing it well—selling micro-electronic products directly to consumers through full-page advertisements in national magazines and newspapers.

HOW WE SELECT A PRODUCT

We have a comprehensive checklist that we go through for each product we select. The questions we ask ourselves include:

1) Does the product use an integrated circuit? (This has been the primary area in which we have concentrated.)

2) Is the product a major breakthrough or a new application of existing technology? (Both are acceptable.)

3) Is the manufacturer a solid, honest company providing honest value?

4) Is the new technology in the product different enough to require the detail we supply in one of our advertisements? (If it is not, then our pioneering efforts are not required, and the product may not be that innovative.)

5) Does the product have advantages over the conventional version? Does it do its job more efficiently, faster and for less money? ("Less money" is the most important key.)

6) Can the consumer figure out how to operate it without reading the instructions? If not, how badly is the consumer willing to read the instructions?

7) Is the warranty and back-up service well thought out in advance?

8) Is the product at least one year ahead of all other similar products currently on the market?

9) Is the product a gimmick or an honest and useful contribution to new technology?

10) Can our company sell enough of the product to make a decent profit? (If the product appeals to too narrow a population segment, then we cannot sell enough of a product to keep our margins low enough to provide good value.)

DISCOVER OUR PRODUCTS

How do you find out about these products? Until now, to follow our company and its product introductions, you had to be a reader of *Popular Science* or any of 50 national publications we advertise in or be one of our existing customers.

JS&A will produce its second major catalog listing the newest consumer micro- electronic products that we feel represent the best contributions to micro-electronic technology.

If you are a JS&A customer, you will automatically receive one. If you are not, we will be happy to send it to you. It is called "products that think"—a collection of the most advanced micro-electronic consumer products. If you wish to receive one, simply send a postcard or a letter to: Catalog Section, JS&A National Sales Group, One JS&A Plaza, Northbrook, Illinois 60062.

On the following three pages in this issue of *Popular Science* are also a few of the products we are proud to introduce for the first time—products that we feel represent the quality, value and the innovation associated with our company.

Finally, we owe a debt of gratitude to our customers and to micro-electronics—the science of the future. We are proud of our position in this field, and we hope our contribution has helped further this new technology and made possible the many conveniences now available to consumers.

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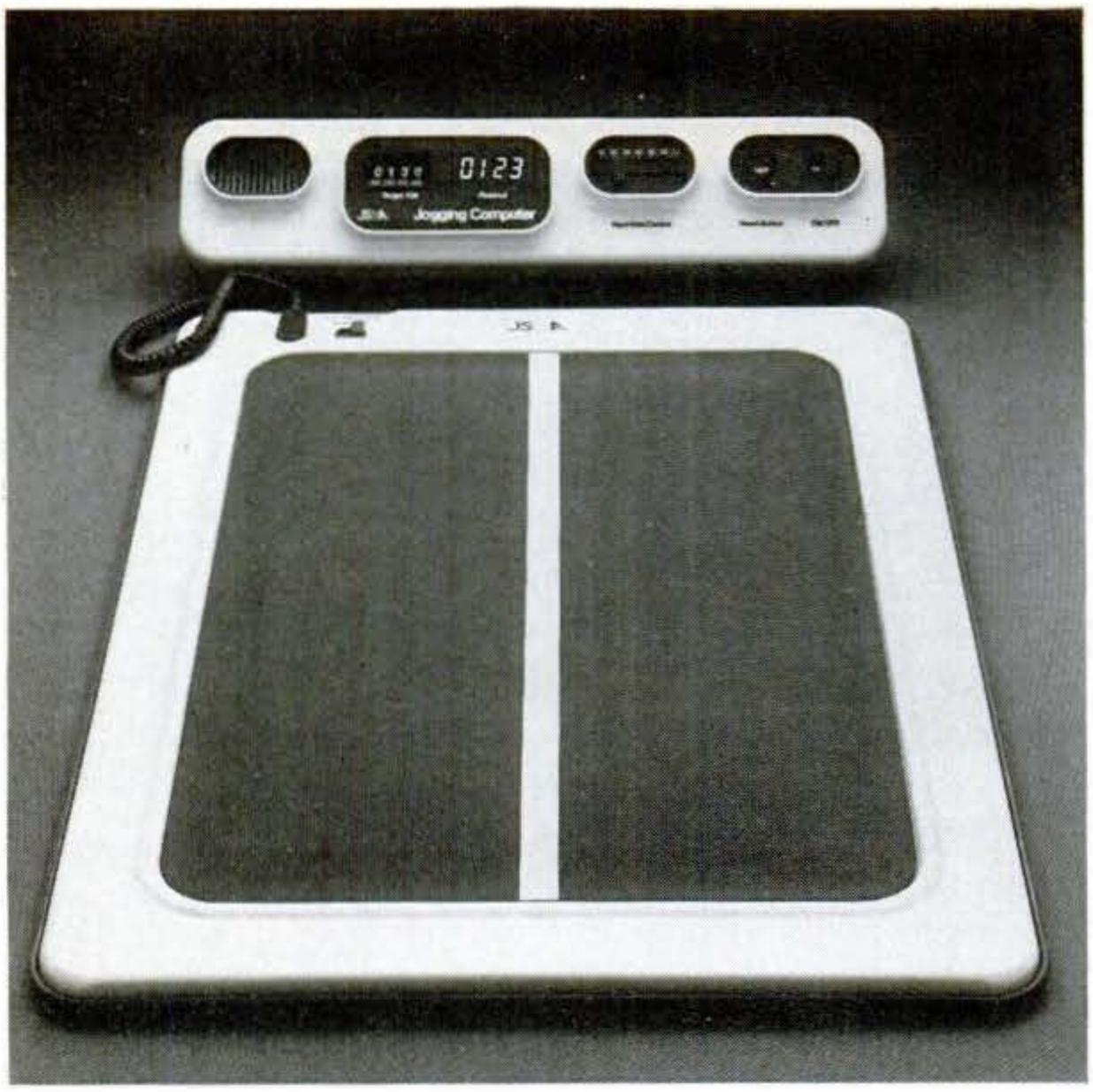

Jogging Computer

Make jogging fun in the privacy of your home with a new space-age indoor exercise system.

The JS&A Jogging Computer is a total system of physical fitness and conditioning.

It's a fact. You reach your physical peak at age 25 and your mental peak at age 40. From then on it's downhill. But it needn't be. A 50 year old who exercises regularly can be healthier and in better physical shape than the average 25 year old.

When you're physically healthy, you are alert and better able to handle stress. You are better motivated and just plain happier. Jogging can keep you in good physical shape.

THE ADVANTAGES OF JOGGING

Jogging as a regular exercise has gained in popularity because it does three things for you. 1) It improves the functioning of the heart, lungs, blood vessels and lymph glands. 2) It helps control your weight without resorting to starvation diets, and 3) It is one of the few safe, strenuous exercises that creates the exertion necessary for good physical conditioning.

A NEW JOGGING COMPUTER

There is now a new, fun way to jog. The new JS&A Computer is a solid-state system that lets you jog in place in the comfort of your own home. It's fun, easy to use and convenient.

You simply set the distance and pace you wish to run and press the start button. An audible beep tone sounds and you jog in place to its rhythm. Each stride is registered on a large LED readout in the control unit so you can see how far you've run.

You jog on a large pad with sensors which register each stride. The pad is designed to feel like grass or soft earth so you can run either barefooted or with gym shoes. The idea is to gradually increase your distance and speed each day to build up your endurance.

Getting yourself to start jogging is often the hardest step. That is why the JS&A Jogging Computer is an ideal system for both the beginner and the experienced jogger.

FOR THE BEGINNER

The first time you step on the Jogging Computer, you run at a pre-selected pace and distance for approximately five minutes. (A chart will show you which speed to select based on your sex and age.) You then take your pulse rate for one minute by touching your wrist. The pulse/rate chart determines the settings and distance you should run the next time you jog.

You could be in poor, average or good shape, and this simple five minute test will accurately tell you. Start the jogger at the distance indicated on the chart, and gradually build up a little each day. In just one week you'll notice the difference, feel great, have greater endurance, and you won't tire as easily. That is what's so nice about the system – how easily and quickly it puts you into better shape.

FOR THE EXPERIENCED

If you jog regularly, you know the many benefits of jogging. But you also know the disadvantages – all overcome by owning a Jogging Computer. For example:

Forget about the ritual You wake up early, drive to your favorite indoor track, change clothes, and you're ready to run. With the Jogging Computer, just step out of bed and start running. The time you save in preparing to jog can be substantial.

Forget about the boredom Running around a track can be quite boring. And if you count laps, how many times have you lost your count? With the Jogging Computer, you can forget about counting, as the unit does it automatically for you. You can concentrate on problems or take flights of fancy – all while you strenuously exercise.

Forget about the weather Even in summer, there are days when you can't jog outdoors. And in a daily exercise program, you must resort to the indoor track. Not so with the Jogging Computer. It's always there when you need it – portable and ready to operate.

Forget about jogger's heel If you've run on indoor tracks, you know the pain of jogger's heel caused by leaning in around those curves. Jogging in place is easier on your whole body and eliminates this common jogging problem.

BRING IT ANYWHERE

The Jogging Computer is powered by four "C" cell batteries and requires no AC power so it goes anywhere – on your patio, in the garage or basement, or at your office. The control unit can be propped up with its built-in easel or placed on a wall using the four foot expansion cord. It's portable, so after you've run a few miles, just turn it off and put it away. There's no large exercise device to take up space.

QUALITY THROUGHOUT

The JS&A Jogging Computer is all solid state, and the 17"x 22" pad was pre-tested to take years of constant, hard pounding under all conditions. Service should never be required, but if anything ever does go wrong, JS&A's service-by-mail center will have it repaired and back to you in a matter of days. Be assured that we stand solidly behind our product's quality, construction and design. JS&A is America's largest single source of space-age products. We've been in business over a decade – further assurance that your modest investment is well protected.

We suggest that you order the JS&A Jogging Computer and use it for 30 days. Jog each day when you get up in the morning or before dinner. Enjoy the thrill of feeling your endurance build. Experience the convenience and fun. See how much better you feel and how much sharper you think. Then after 30 days, measure your progress. If you don't find the JS&A indoor jogger a convenient and fun way to stay trim and healthy, then return your unit for a complete and full refund including the $3.00 charge for postage and handling. You can't lose.

Simply send your check for **$149.95** plus $3.00 postage and handling (Illinois residents add 5% sales tax) to the address below or call our toll-free number. By return mail, we will send you the complete jogging computer system with instructions, charts, personal score card and a one year limited warranty.

Start today on an organized physical fitness program using the latest in solid-state, space-age technology. Order your JS&A Jogging Computer at no obligation today.

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HATS OFF TO IBM

Printer Break-through

A new 10-digit display calculator with the world's first dual-element integrated printing head will revolutionize the printing calculator.

The full-featured $89.95 Canon P10-D with its one-year parts and labor limited warranty is the greatest printer value ever offered by JS&A.

Hats off to IBM. Their single-element typing system did away with typewriter keys and started a new technology.

The new Canon P10-D printing calculator starts another new technology. Their dual-element printing system does away with the standard printing head which required a separate disc for each column. The Canon has only two discs—one with digits and the other with symbols.

The P10-D head weighs only ½ ounce compared to 31 ounces in a typical printing head. Its motor weighs only nine ounces—again much less than the heavier conventional motors required to drive larger heads. The Canon motor is smaller, lighter and more efficient because it moves less weight.

THE MOST EFFICIENT SYSTEM

The printing head is controlled by an LSI (large scale integrated circuit). As you press a key, a pulse is generated from this circuit and sent to the motor which does two things: 1) positions the two discs to print the numbers or symbols and 2) glides the numeric disc across the ten column width of the paper.

Conventional printers print from metal discs through thick fabric ribbon onto paper. The Canon system prints directly on paper so each impression is sharp, clear and easy to read. The synthetic polymer disc is first inked by a special cartridge before it prints. Each ink cartridge is easily replaceable. The cartridge lasts for more than 15 rolls of paper at a cost of 17¢ per roll—far less than any other system.

PLAIN PAPER PLUS

Using standard paper tape is only one of several advantages that make the Canon a truly spectacular value. Here are some other exciting new features:

Dual Power Operate the Canon from either your AC outlet or its built-in rechargeable batteries. It's totally portable, yet it also makes a handsome desk calculator.

Dual Display Just flip a switch and the 10-digit large green fluorescent display can be used with or without the printer.

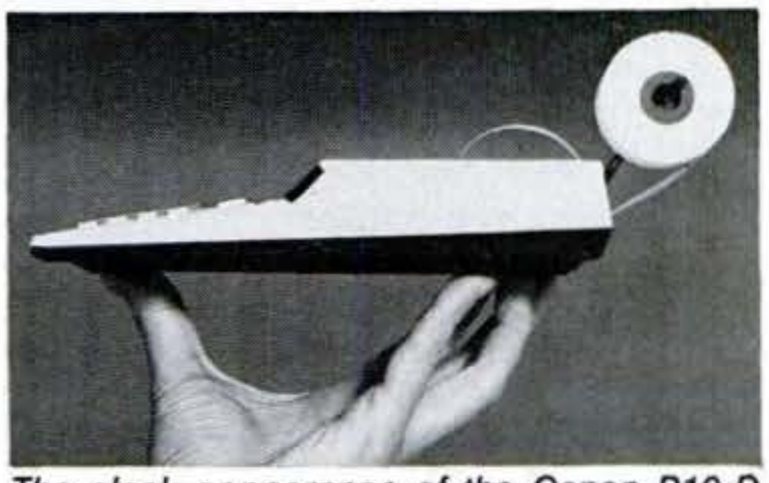
Space-Age Styling Compare the sleek appearance of the Canon with any other printer. It's small enough to fit in your briefcase and large enough to use as a space-saving desk unit. It measures only 1¾" x 4¼" x 8½", weighs only 24 ounces and the paper tucks into the body of the unit—perfect for travel.

Buffered Keyboard If you enter your problems faster than the printer can print them out, don't worry. The unit's memory stores your keystrokes and prints them out in rapid succession.

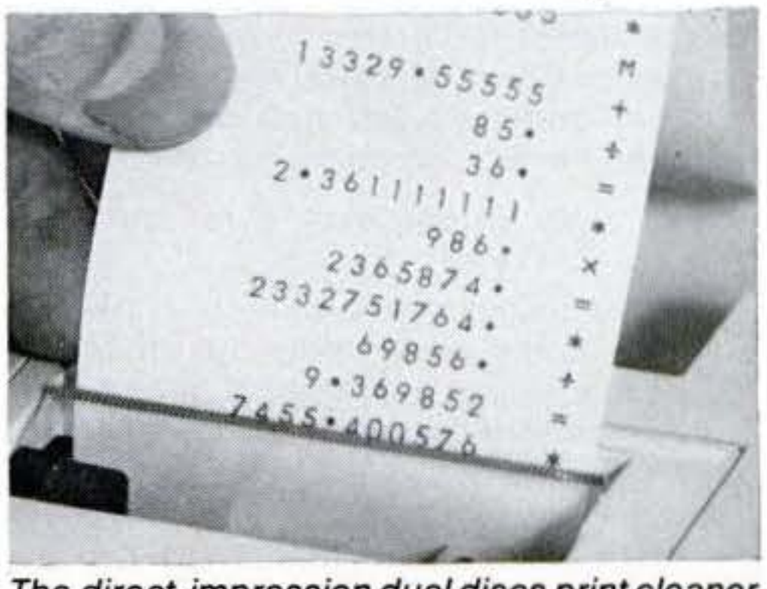
We have always looked at small printers as gimmicks—calculators that lack many important features. We were surprised with the Canon. It has features that far exceed most printers costing hundreds of dollars more.

The following is a list of those features: 10 digit capacity • full four-key memory • addition, subtraction, multiplication and division • percentage key • add-on and discount calculations • power and reciprocal calculations • repeat calculations • add-mode • switch for full-floating or second and third fixed decimal positions • round off or round down switch • paper tape advance.

There are other convenient features that make it perfect for people who spend hours at their calculators. There's a three-digit item counter that counts and prints out the number of entries while printing your total. The symbols on the right side of the tape tell you the nature of each entry. Even in its battery operated position, you could print out more than half a roll of tape before the unit signals you that its batteries are low.



The sleek appearance of the Canon P10-D makes it a handsome addition to any desk.



The direct-impression dual discs print cleaner and sharper on conventional paper tape.

A NEW WAY TO BUY

JS&A offers you a new way to buy your 10-digit Canon P10-D. First we give you the opportunity to use one for 30 days. Carry it in your briefcase. Put it on your desk and see how handy it becomes and how little space it takes up. Check the paper tape and see how clear and easy-to-read it is. Bring it home and let the whole family use it.

Then, within 30 days, decide. If the Canon is not perfect for you, return it for a prompt and courteous refund. And if you do return it, not only will we still consider you one of our good customers, but we will also refund your $2.50 postage, let you keep the paper tape, and thank you for giving us the opportunity of showing it to you. We couldn't be more positive about the quality and value of this incredible new product.

JS&A is America's largest single source of space-age products. We have been in business for over a decade—further assurance that your modest investment is well protected. Canon is one of the world's largest manufacturers of cameras and precision quality instruments and is highly respected as a quality manufacturer of electronic products.

The Canon costs only **$89.95** plus $2.50 for postage and handling and includes a free roll of tape, one ink cartridge, rechargeable batteries and a power cord/charger. It's an incredible value thanks to its new technology. To order, send your check to the address below (Illinois residents add 5% sales tax) or credit card buyers may call our toll-free number.

Space-age technology has produced another major product breakthrough. Order your Canon P10-D at no obligation today.

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Burglar Alarm Breakthrough

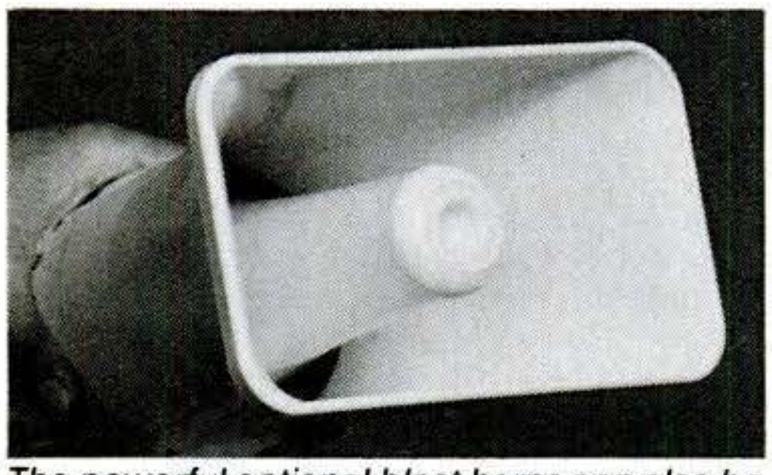
The Midex security computer looks like a handsome stereo system component and measures only 4"x 10½"x 7."

A new computerized burglar alarm requires no installation and protects your home or business like a thousand dollar professional system.

It's a security system computer. You can now protect everything–windows, doors, walls, ceilings and floors with a near fail-safe system so advanced that it doesn't require installation.

The Midex 55 is a new motion-sensing computer. Switch it on and you place a harmless invisible energy beam through more than 5,000 cubic feet in your home. Whenever this beam detects motion, it sends a signal to the computer which interprets the cause of the motion and triggers an extremely loud alarm.

The system's alarm is so loud that it can cause pain–loud enough to drive an intruder out of your home before anything is stolen or destroyed and loud enough to alert neighbors to call the police.



The powerful optional blast horns can also be placed outside your home or office to warn your neighbors.

Unlike the complex and expensive commercial alarms that require sensors wired into every door or window, the Midex requires no sensors nor any other additional equipment other than your stereo speakers or an optional pair of blast horns. Its beam actually penetrates walls to set up an electronic barrier against intrusion.

NO MORE FALSE ALARMS

The Midex is not triggered by noise, sound, temperature or humidity–just motion–and since a computer interprets the nature of the motion, the chances of a false alarm are very remote.

An experienced burglar can disarm an expensive security system or break into a home or office through a wall. Using a Midex system there is no way a burglar can penetrate the protection beam without triggering the loud alarm. Even if the burglar cuts off your power, the four-hour rechargeable battery pack will keep your unit triggered, ready to sense motion and sound an alarm.

DEFENSE AGAINST PEEPING TOMS

By pointing your unit towards the outdoors from your bedroom and installing an outside speaker, light, or alarm, your unit can sense a peeping Tom and frighten him off. Pets are no problem for the Midex. Simply put them in one section of the house and concentrate the beam in another.

When the Midex senses an intruder, it remains silent for 20 seconds. It then sounds the alarm until the burglar leaves. One minute after the burglar leaves, the alarm shuts off and resets, once again ready to do its job. This shut-off feature, not found on many expensive systems, means that your alarm won't go wailing all night long while you're away. When your neighbors hear it, they'll know positively that there's trouble.

PROFESSIONAL SYSTEM

Midex is portable so it can be placed anywhere in your home. You simply connect it to your stereo speakers or attach the two optional blast horns.

Operating the Midex is as easy as its installation. To arm the unit, you remove a specially coded key. You now have 30 seconds to leave your premises. When you return, you enter and insert your key to disarm the unit. You have 20 seconds to do that. Each key is registered with Midex, and that number is kept in their vault should you ever need a duplicate. Three keys are supplied with each unit.

As an extra security measure, you can leave your unit on at night and place an optional panic button by your bed. But with all its optional features, the Midex system is complete, designed to protect you, your home and property just as it arrives in its wellprotected carton.

The Midex 55 system is the latest electronic breakthrough by Solfan Systems, Inc.–a company that specializes in sophisticated professional security systems for banks and high security areas. JS&A first became acquainted with Midex after we were burglarized. At the time we owned an excellent security system, but the burglars went through a wall that could not have been protected by sensors. We then installed over $5,000 worth of the Midex commercial equipment in our warehouse. When Solfan Systems announced their intentions to market their units to consumers, we immediately offered our services.

COMPARED AGAINST OTHERS

In a recent issue of a leading consumer publication, there was a complete article written on the tests given security devices which were purchased in New York. The Midex 55 is not available in New York stores, but had it been compared, it would have been rated tops in space protection and protection against false alarms–two of the top criteria used to evaluate these systems. Don't be confused. There is no system under $1,000 that provides you with the same protection.

YOU JUDGE THE QUALITY

Will the Midex system ever fail? No product is perfect, but judge for yourself. All components used in the Midex system are of aerospace quality and of such high reliability that they pass the military standard 883 for thermal shock and burn-in. In short, they go through the same rugged tests and controls used on components in manned spaceships.

Each component is first tested at extreme tolerances and then retested after assembly. The entire system is then put under full electrical loads at 150 degrees Fahrenheit for an entire week. If there is a defect, these tests will cause it to surface.

PEOPLE LIKE THE SYSTEM

Wally Schirra, a scientist and former astronaut, says this about the Midex 55. "I know of no system that is as easy to use and provides such solid protection to the homeowner as the Midex. I would strongly recommend it to anyone. I am more than pleased with my unit."

Many more people can attest to the quality of this system, but the true test is how it performs in your home or office. That is why we provide a one month trial period. We give you the opportunity to see how fail-safe and easy to operate the Midex system is and how thoroughly it protects you and your loved ones.

Use the Midex for protection while you sleep and to protect your home while you're away or on vacation. Then after 30 days, if you're not convinced that the Midex is nearly fail-safe, easy to use, and can provide you with a security system that you can trust, return your unit and we'll be happy to send you a prompt and courteous refund. There is absolutely no obligation. JS&A has been serving the consumer for over a decade–further assurance that your investment is well protected.

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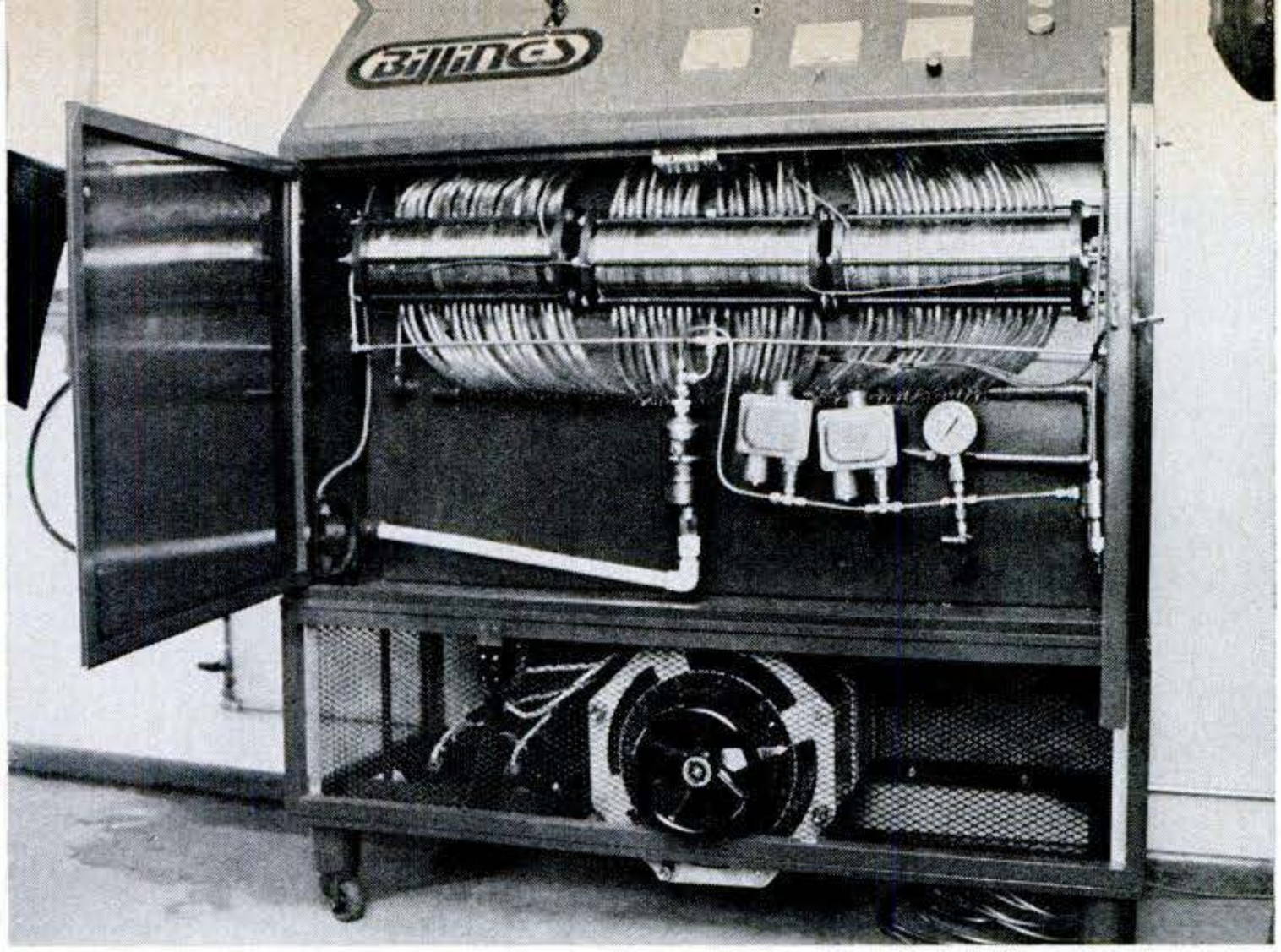

Billings' electrolyzer splits water molecule into oxygen and hydrogen. Hydrogen atom follows electric current past a membrane, leaving oxygen behind.

Billings has converted more vehicles to hydrogen, including the dual-fuel Cadillac Seville that was featured in President Carter's inaugural parade.

Now Billings has taken the first step in creating what may be the world's first hydrogen mini-economy: a cluster of some 30 houses plus a small industrial park, all powered by hydrogen.

For the present, the Homestead's hydrogen is generated by electrolysis, using power from the local utility. Future plans call for a small hydroelectric plant [see "Water Power," PS May 1977] and a wind turbine. Ultimately Billings plans to generate hydrogen with a coal-gasification plant the company will construct nearby. In this process, steam is forced through powdered coal at high temperatures. The oxygen unites with carbon to form carbon dioxide. The hydrogen, released as a gas, is then collected.

The Homestead's hydrogen is stored in a well-insulated, two-ton hydride tank, dubbed R2D2. In hydride storage, the tank is filled with a compound that has an affinity for hydrogen—a hydride. In this case it is iron-titanium. Hydrogen enters the tank at 500 psi and is absorbed by the hydride, much as a sponge absorbs water. To release the hydrogen, you need heat. In the

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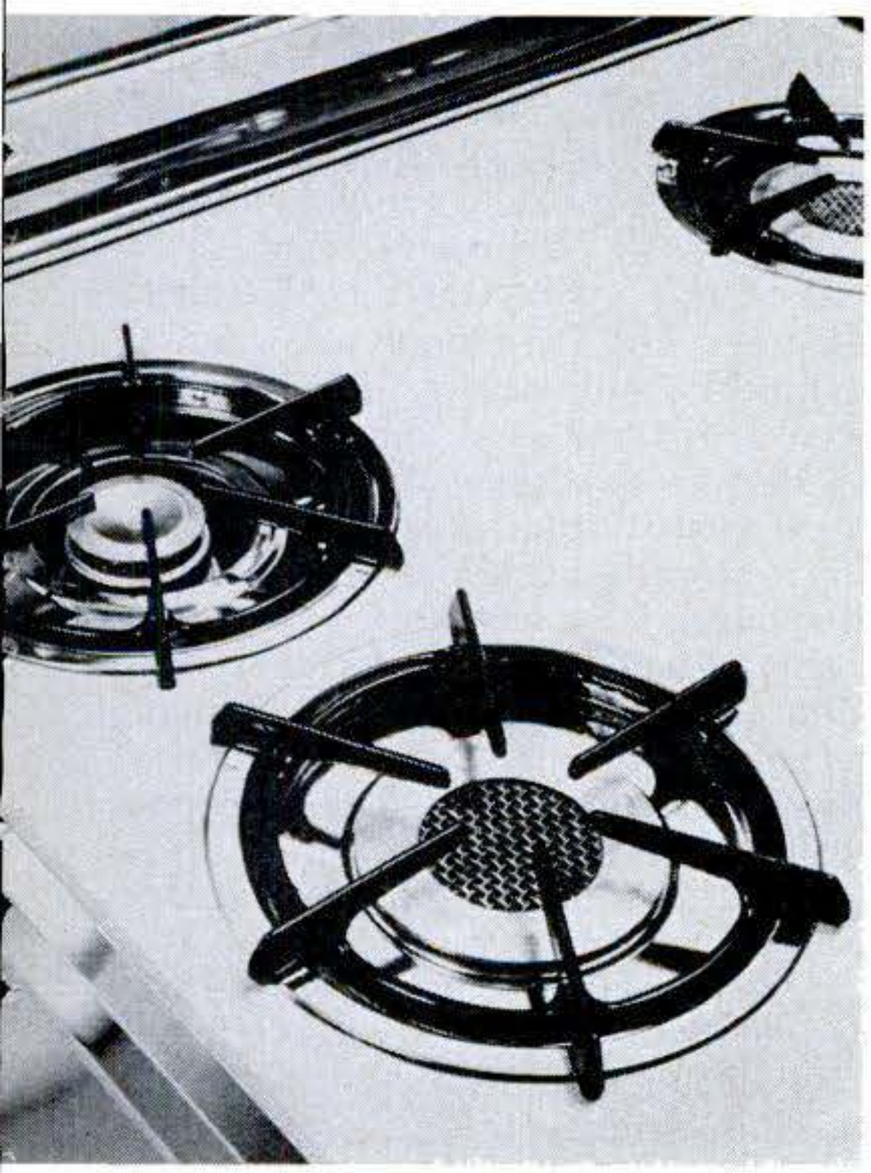
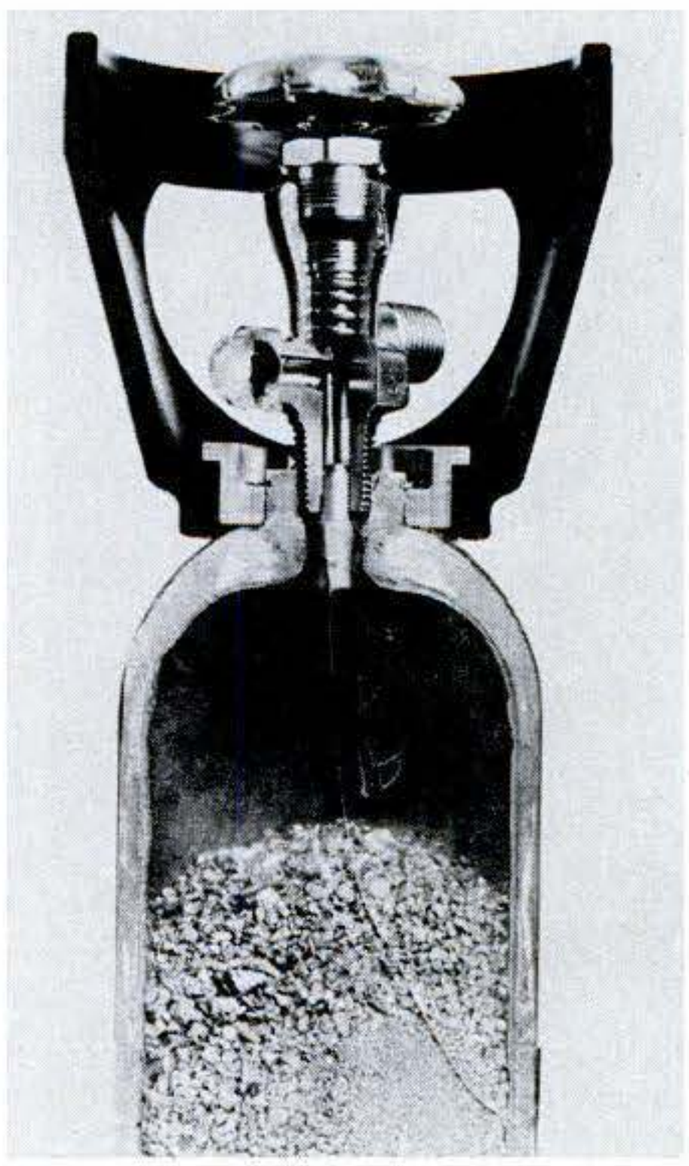
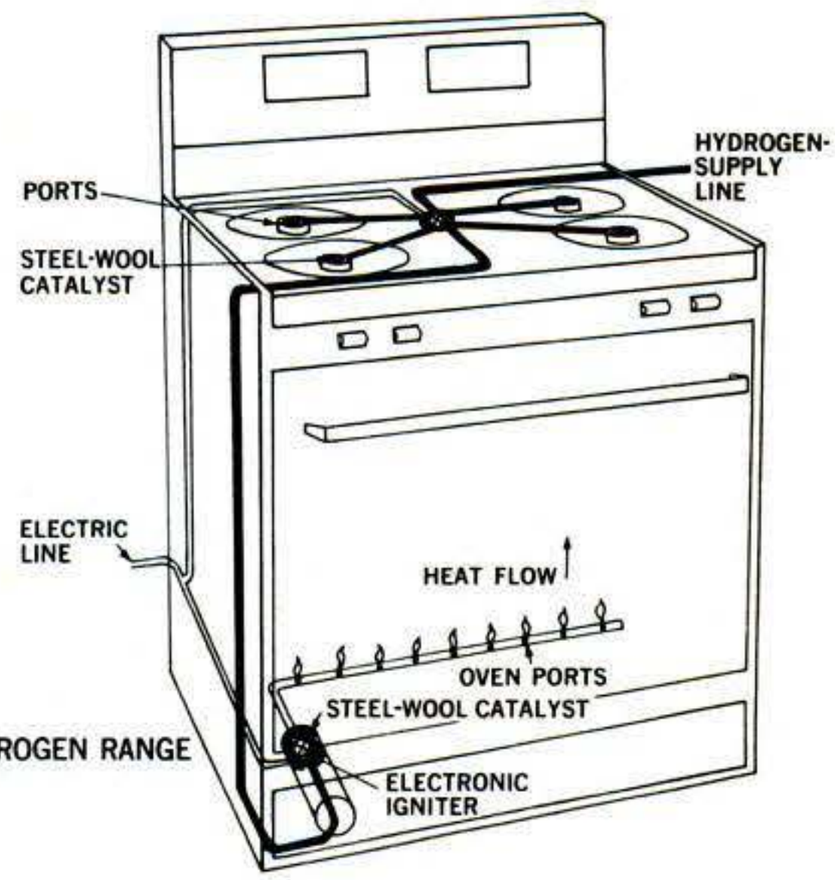


Hydrogen burner on Tappan range has steel mesh that glows when heated to show burner is on (hydrogen flame is colorless). Standard burner is at rear.



Cutaway tank shows chips of iron-titanium, a hydride. When hydrogen gas is pumped in, hydride soaks it up; as heat is applied, hydride releases gas.



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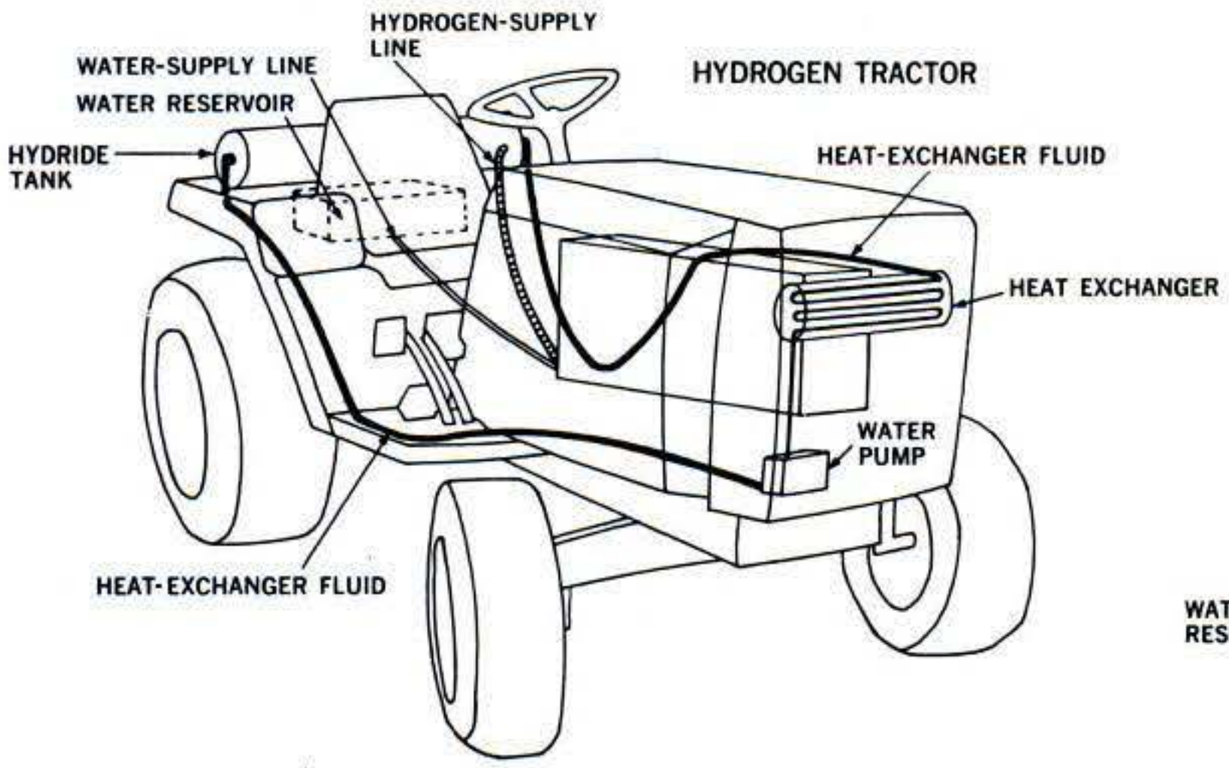

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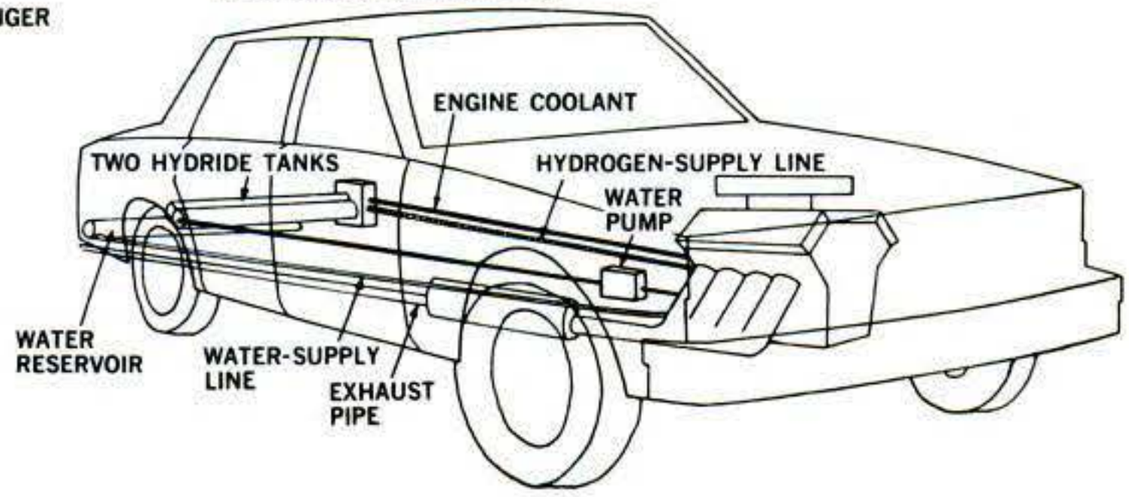

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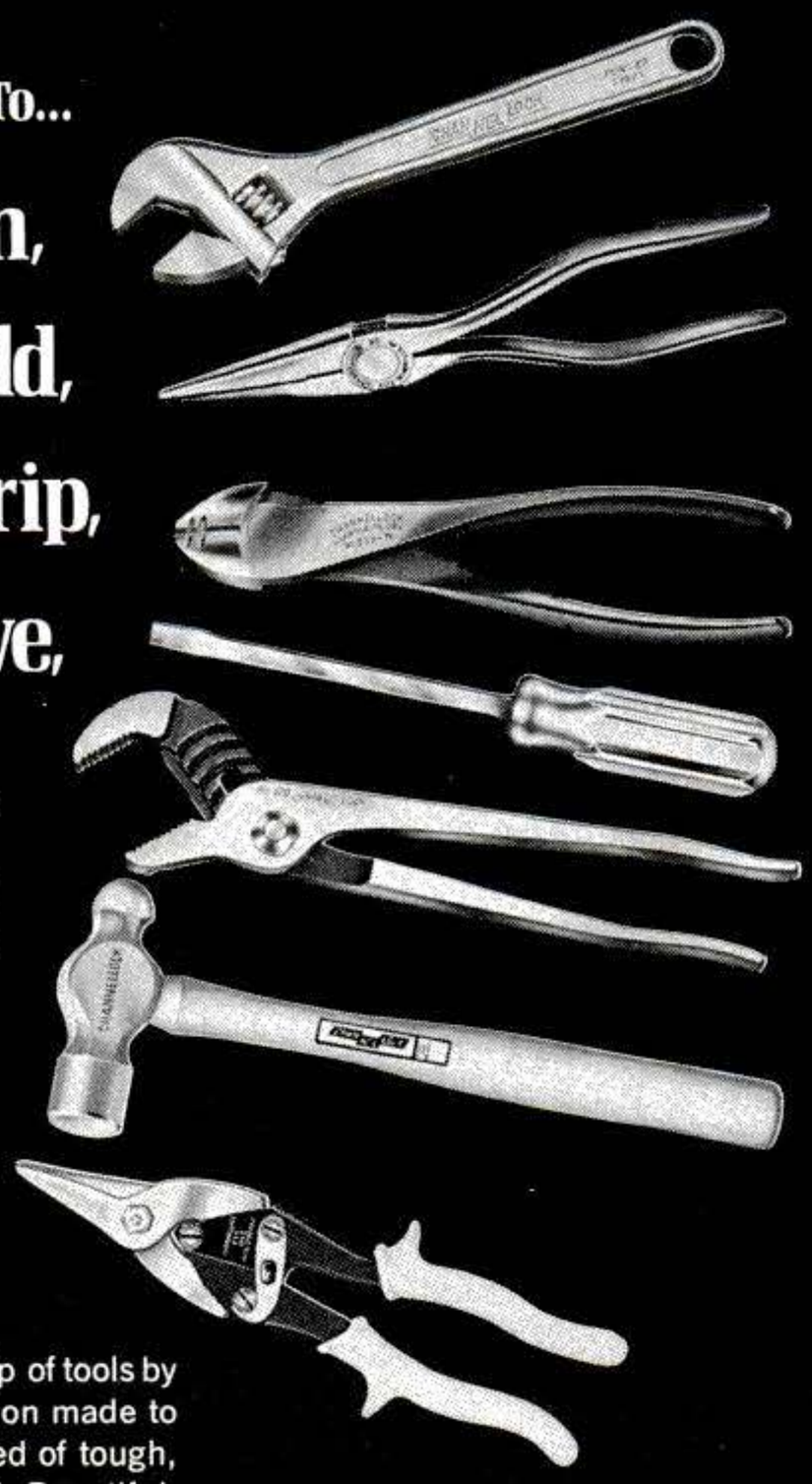

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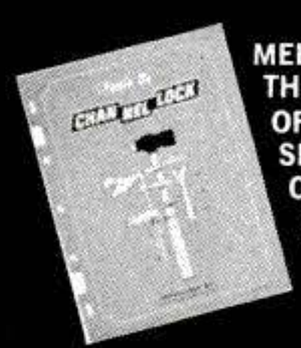

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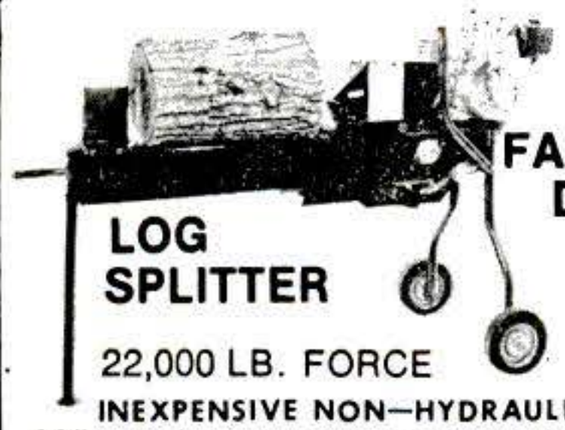

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Hydrogen homestead

[*Continued*]

Homestead this is supplied by solar collectors. Iron-titanium is claimed to have a virtually unlimited life.

Why hydride storage? It's the safest way known to store hydrogen. In tests conducted at Tooele Army Depot near Salt Lake City, armor-piercing incendiary bullets were fired into fully charged hydride tanks. The small flame that resulted self-extinguished in seconds. Other methods of hydrogen storage—in compressed gas or liquid form—are more costly and potentially dangerous.

What's cooking

In the Homestead's kitchen, hydrogen fuels the range and oven. Conventional appliances were converted by Tappan to Billings' catalytic system. First, the primary air supply is closed off. In a typical gas appliance, air is mixed with natural gas before it reaches the burner for a proper air-gas combustion mixture. With hydrogen this isn't necessary; updraft in the hydrogen flame sucks in enough oxygen to support combustion. The hydrogen is ignited electronically.

Because hydrogen has a vertical heat distribution—the flame is hot on top with little heat radiated to the sides—the gas port is covered with a steel-wool catalyst to spread the flame and distribute heat more evenly. This also lowers the combustion temperature so that oxides of nitrogen are not formed.

Hydrogen also fuels the Homestead's domestic water heater; the supplemental gas furnace (a heat pump provides primary space heating and air conditioning); artificial logs in fireplaces; and an outdoor barbecue.

Vehicles, too, are included in the Homestead's energy system:

- A dual-fuel Cadillac Seville, with two hydride tanks, can run 50 to 60 miles on an overnight charge of hydrogen. The car uses engine heat to liberate hydrogen from the hydride storage tanks (see drawing). To run on regular gas, you merely flip a switch.
- A 20-hp Jacobsen lawn tractor, with a single hydride tank mounted behind the driver's seat, will run for an hour on a two-to-three-minute charge, according to Billings. Engine heat also frees the hydrogen in this vehicle (see drawing).

Billings' Homestead is an impressive step toward the hydrogen economy; we'll follow their progress to keep you informed. PS

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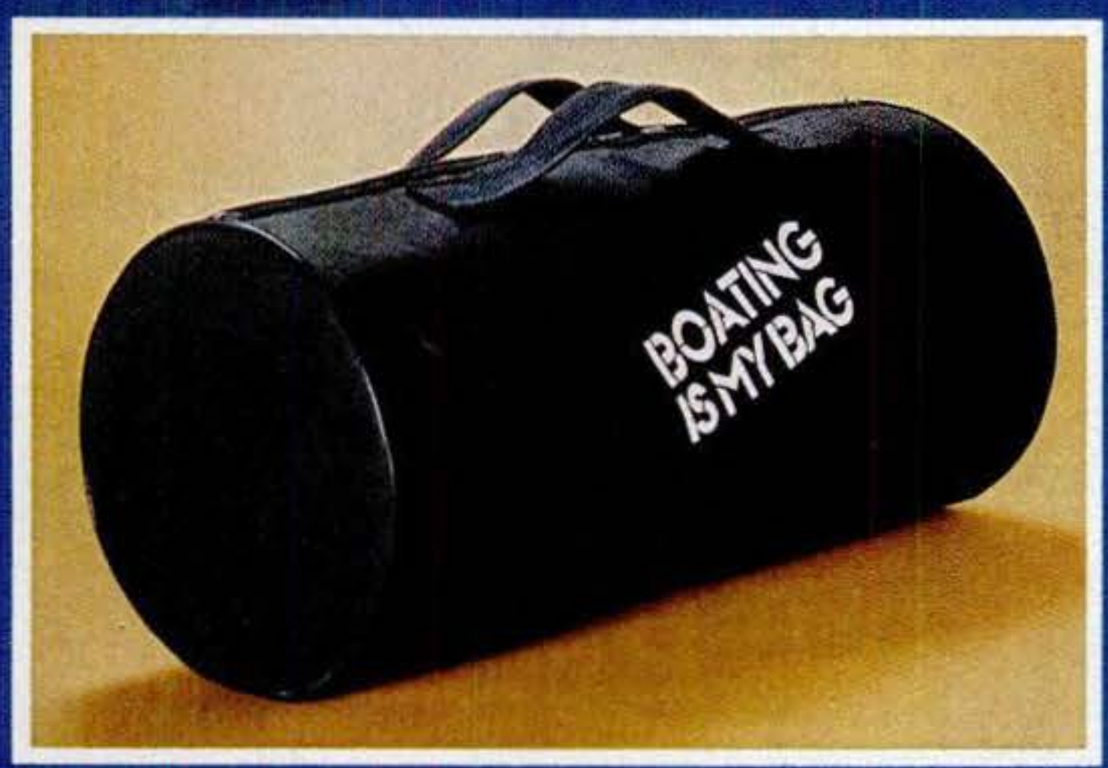

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PS car test & driving report

New four-wheel-drives

—comfortable inside, tough off the road

Jeep Cherokee, foreground, leads the Chevy Blazer, Plymouth Trailduster, and the all-new Ford Bronco out of a gully.

PS ratings—test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars, and that other seemingly identical cars may vary in performance. Also, weather conditions (noted in our spec table) vary from test period to test period. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Bronco	Blazer	Cherokee	Trail-duster
Fuel economy	0	0	0	0
Acceleration	5	5	5	5
Braking	3	2	4	3
Handling*	1	1	2	1
Maneuverability*	3	4	2	2
Ride comfort	2	1	2	1
Quietness	1	0	0	0
Roominess	4	4	4	4
Visibility	1	1	2	2
Entry/exit ease	3	3	3	3

* Ratings for on-road performance only

By JIM DUNNE and RICH CEPPOS

If you've never been inside a four-wheel-drive, you may be in for a surprise when you first climb aboard. Until a decade ago, 4WD's were little more than military vehicles in civilian paint—small and rough-riding, with easily removable doors and tops, and Spartan interiors you could hose out. That all changed in 1969 when Chevrolet introduced the Blazer, a much larger

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vehicle that offered luxury levels formerly unknown in 4WD's. It started a trend that is still clearly evident in our four test rigs: AMC Jeep Cherokee "S", Ford Bronco Ranger XLT, Chevrolet Blazer Cheyenne, and Plymouth Trailduster Sport.

The Bronco has been totally redesigned for '78 to match the Blazer's size and luxury. The old Bronco was compact, slab-sided, and Spartan, with barely room for four people and a relatively light payload capacity of about 900 pounds. The new model is over two feet longer, five inches taller, and 11 inches wider, and weighs a whopping 1200 pounds more. Its payload is up by 50 percent, and there is much more cargo and passenger room. "Buyers were choosing the Blazer because of its larger cargo area and payload capacity," explained James E. Englehart, Ford Truck Division Product Planning Manager.

"They want to travel in comfort off-road. They also want a vehicle that's comfortable on the road because they can't afford a second car. The old Bronco sold to hardcore off-roaders. The new one should appeal to a wider group."

In most respects, our four test rigs are very similar. They are all derived from other vehicles. All but the Jeep share their power train and sheet metal from the doors forward, with their company's light-duty pickups; they have unique bodies from the doors aft. Their roofs are fiberglass and are removable, though it takes considerable effort to get them off. The Jeep, however, is a two-door version of the AMC Wagoneer station wagon. It shares the Wagoneer's fixed steel roof but has a slightly different side-window treatment.

All of the vehicles are available with full-time four-wheel drive. As the term implies, all four wheels are always engaged, so you can go directly from paved roads to unpaved trails without stopping. With the part-time system, you can't drive on dry pavement with all four wheels engaged. Doing so creates binding forces that could cause the vehicle to lurch while turning and could damage the system. In order to engage the Ford's part-time 4WD, you have to get out of the car, twist the front hubs to the "locked" position, and shift the transfer case from "2WD" to "4WD."

The new system is made possible by a differential in the transfer case that allows the front and rear wheels to turn at different speeds. The differential can be "locked up" to provide full power to all wheels, regardless of their traction, simply by pushing the transfer-case shift lever into the "locked" range (this is done with a switch in the Jeep). All but the Jeep also have a "low" range in the transfer case for added pull on very steep inclines. Chrysler makes the full-time unit for all the manufacturers except AMC, which buys its QuadraTrac system from Borg-Warner. The part-time system is still available on the Ford.

Another thing the 4WD's have in common is enormous interiors. The high-line trim options in our test vehicles imparted car-like luxury. Each of our trucks had comfortable cloth-and-vinyl front bucket seats and a large rear bench seat. The floors and cargo areas were covered with car-quality cut-pile carpeting, and the doors and side panels were upholstered as well. Comfort and convenience options abounded, as did many other costly, mostly car-like extras and options (see spec table). About 50 percent of 4WD models are equipped like ours. The remainder are sold, with lesser levels of trim, to residents of desert regions, people living in areas where there is heavy snowfall, and those who travel off-road a great deal or use their 4WD's for purposes other than recreation.

The only problem we found with the interiors was that rear-seat passengers had a hard time getting out of them. Despite fairly large door openings and front seats that fold forward, you stumble out of the back because you're much higher off the ground than in a standard sedan.

In general, handling on paved surfaces was poor. The trucks suffered from slow, vague steering that also had little road feel or self-centering action. On the highway, you have to pay extra attention in order to keep them in lane. Their great height (67-76 in.), and their hefty weight (3900-4700 lbs.) make them tippy enough to feel as if they're going to roll over when you try quick emergency lane changes. That's unnerving. Their girth also makes city driving a chore, for you

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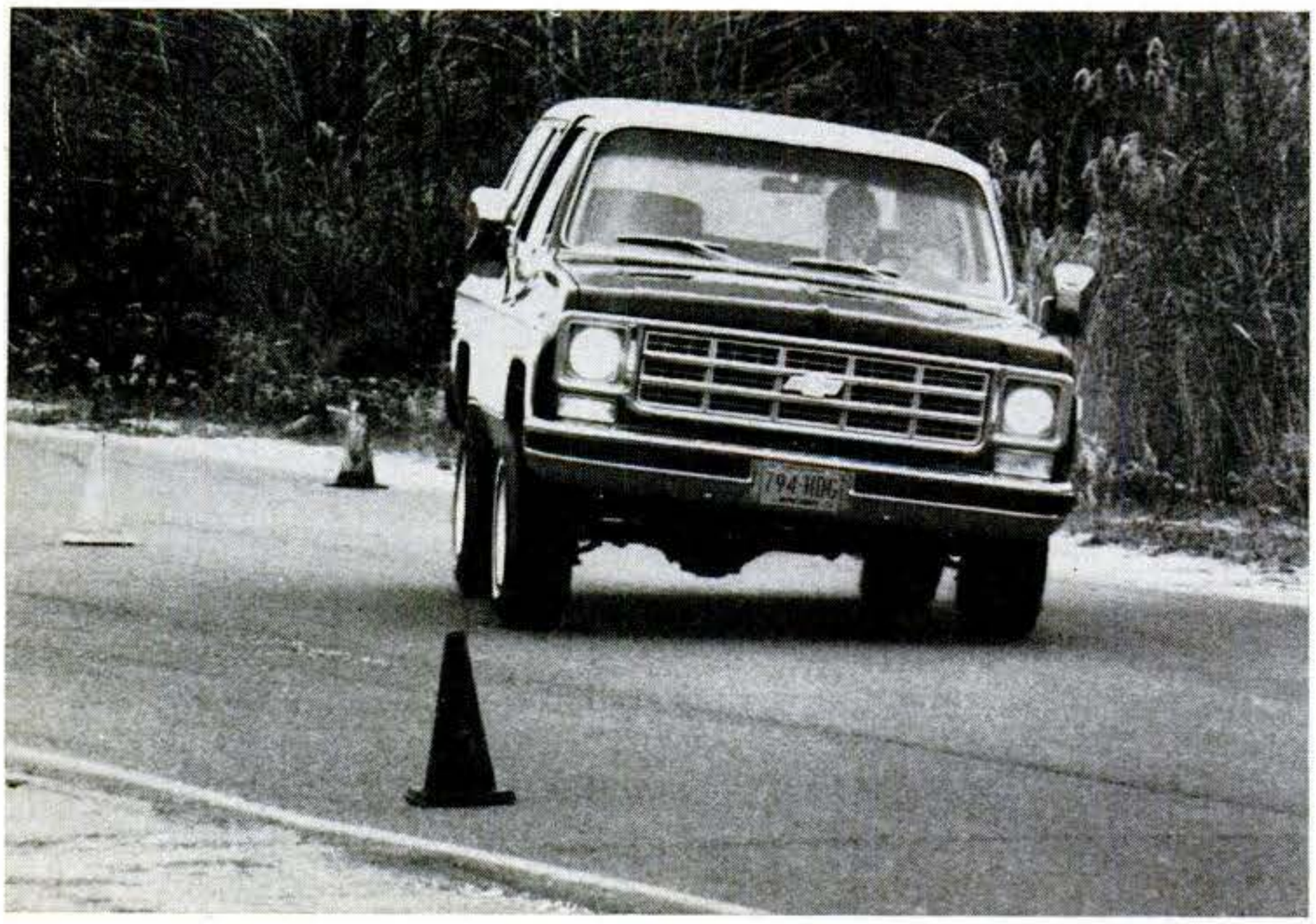
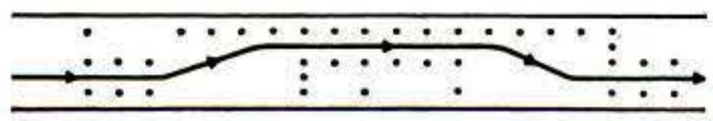


Fuel mileage (mpg)

	Bronco	Blazer	Cherokee	Trailduster
Combined highway/city off-road driving	10.2	10.0	9.4	9.3



Blazer exits PS emergency lane change (diagram above) with high degree of body roll. Below-average on-road handling was typical of our test vehicles. All of them suffered from vague steering, poor directional stability, and choppy ride. Braking and acceleration equalled that of sedans, but gas mileage was terrible.

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Bronco plows through deep mud puddle. Like all the 4WD's, it made short work of rough terrain despite street tires. High, broad hood impaired visibility.

Trailduster's interior was typical of our high-line off-road vehicles; it includes cloth-and-vinyl bucket seats, carpeting, AM/FM stereo-CB, and much more.

have to be extra careful in threading through traffic: Places you could ease through in a car become tight squeezes for one of these rigs.

Braking performance, however, was a real surprise. All four test vehicles stopped as well as many cars, and with no fuss.

On smooth roads the vehicles were surprisingly smooth, but on bumpy surfaces they were choppy and harsh. Overall, the ride wasn't as poor as that of pickup trucks, but even the best-riding of them, the Cherokee, couldn't quite match the ride of a sedan. The poor ride quality and awkward handling made them, at best, marginally acceptable as road vehicles.

But once you turn off the road you leave handling problems far behind. All four were transformed once the going got rough. In the "outback" their great bulk almost seemed to vanish and was replaced by sports-car nimbleness. We negotiated tight fire trails, soft beach sand, steep rocky gullies, and even deep mudholes with amazing ease and great speed—even though none of the trucks but the Trailduster had off-road tires. They were up to anything we asked of them, and seemed almost unstoppable.

The price of owning one of these rigs is high. Base prices for the stripped versions start at $6000-$6500. And our fully loaded versions ran from $9000 to about $11,000. They'll also keep draining your wallet (and our national fuel supply) at the gas pump: They averaged only about 10 mpg in combined city/highway/off-road driving.

Cherokee

We think the Cherokee was the best compromise between a sedan and a 4WD vehicle. It was the sports car of the group, and had the best handling on the road. Its lower, narrower build made it as easy to drive in traffic as a station wagon, and its ride was the closest to a sedan's, especially on smooth highways. With the optional 401-cu.-in. V8 its acceleration matches the faster '78 cars (0-60 in 11.5 sec.). But for all its road performance, it seemed just as capable as the others off-road. We think it's the best vehicle AMC builds, sedans included.

Bronco

The new Bronco is superior to the old in a number of ways. Interior room and cargo space are greater and payload has been increased by 50 percent, to 1350 pounds. The interior is far more civilized and there is an arm-long list of optional equipment (among other options, our rig had two shock absorbers on each front wheel). On the road it was quiet, only 1 dBA noisier than the AMC Concord sedan that we recently tested.

Problems we found were a balky latch for the fold-down rear seat and a swing-away tire carrier that can damage the tailgate if you're not careful. All in all, it is a good match for its main competitor: the Blazer.

Blazer

The Blazer is little changed from last year. For '78, rear-seat passengers get treated to about three inches more room, the result of a deepened foot well. Though it was faster than all but the Cherokee in handling, the Blazer tipped over so far we thought it might go up on two wheels (it didn't). The interior had a bit less painted metal showing than the Bronco and was a bit noisier, but in most other respects their features and performance are interchangeable.

Trailduster

The Trailduster seemed the most trucklike. It was much noisier than the others, a combination of engine noise and a hum from the fat off-road tires. We suspect the tires partly accounted for the jiggly ride. The Trailduster felt like the bulkiest truck, yet the specs prove it wasn't significantly bigger than the others. Its broad-shouldered hood, which seemed to stretch forever in all directions, is probably partly to blame. The big 440-cu.-in. engine is only a tick slower than the Cherokee to 60 mph, and in handling, on- and off-road performance, and in appointments, the Trailduster is on a par with the other vehicles.

Industry insiders look for another round of changes in the 4WD utility market in the next three years, especially if passenger-car fuel-economy standards are applied to these vehicles. But despite the poor fuel economy and high prices, there are few other vehicles that offer their combination of comfort, utility, and off-road fun. PS

For specs and test results, turn page

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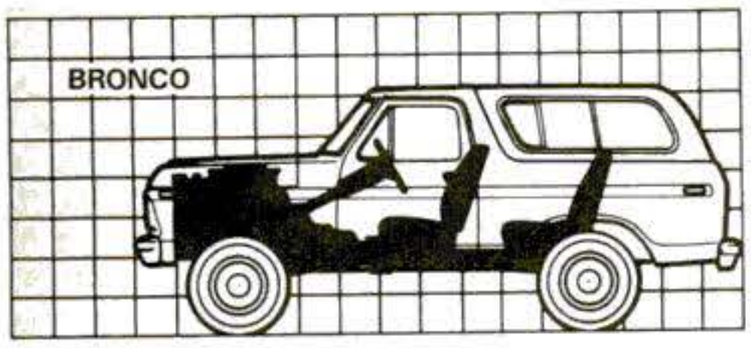

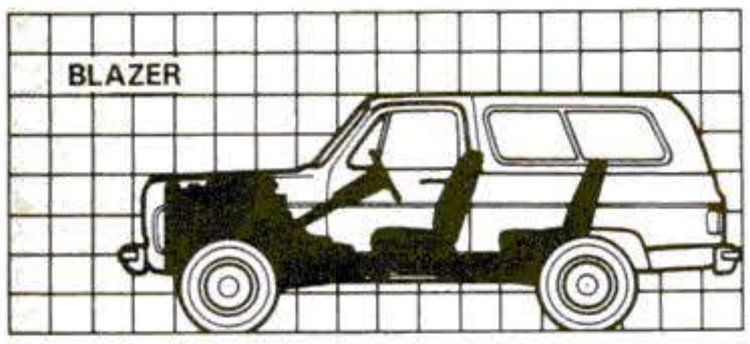

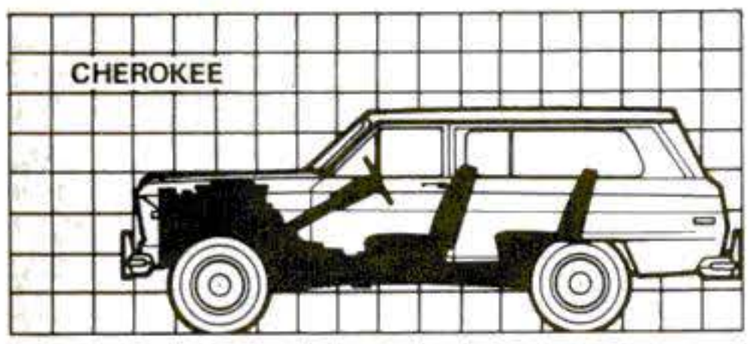

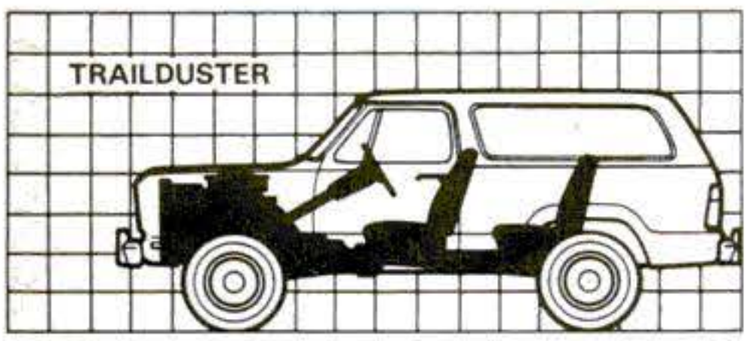

Height of 4WD's limited the visibility and made tight parking a matter of guesswork. They make good tow vehicles: All handle trailers of 5500 lbs. or more.

PS serviceability ratings

How easy is it to service our test cars? To give you an approximation of how easy (or difficult) it is to perform various key service operations, we examine each test vehicle. The numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty; 4, easy; 5, very easy.

	Bronco	Blazer	Cherokee	Trail-duster
Checking fluid levels:				
Battery	4	5	4	4
Master cylinder	3	3	3	3
Windshield washer	5	5	5	5
Engine oil	3	3	3	3
Coolant	3	5	5	5
Checking engine:				
Spark plugs	2	3	3	4
Distributor	3	4	4	2
Carb adjustment	3	3	3	3
Oil filter	3	3	4	4
Oil fill	3	4	4	5
Replacing hoses:				
Top radiator hose	4	5	5	3
Lower radiator hose	3	5	2	3
Heater hoses	2	4	2	2
Changing bulbs:				
Headlights	3	3	3	2
Taillights	1	2	2	2
Front running lights	2	2	2	2
Front parking lights	3	3	3	2
Front directionals	3	3	3	2
Rear directionals	1	2	2	2
Rear running lights	1	2	2	2
Checking fuses	3	3	3	5
Spare-tire accessibility	5	3	1	5
Changing belts	3	3	3	3

Bronco, Blazer, Cherokee, and Trailduster—specs, dimensions, and test results

DIMENSIONS (inches)	**Ford Bronco**	**Chevrolet Blazer**	**Jeep Cherokee**	**Plymouth Trailduster**
Wheelbase	104.0	106.5	109.0	106.0
Overall length	180.3	185.0	183.7	184.5
Overall height	75.5	72.0	67.6	73.3
Overall width	79.3	79.0	75.6	79.5
Track, F/R	64.3/64.4	64.0/62.0	59.0/57.5	65.7/63.2
Ground clearance	7.5	7.3	7.75	8.0
Front head room	37	37.5	35	36
Front hip room*	48	48	44	46
Front leg room	43	42	42	42.5
Rear head room	33.5	35	34	34
Rear hip room	57	50	50	48
Rear leg room (min.)	37	40	40	33
Min. rear knee room	5.5	8	8	4.5
Couple distance	34	37	36	36
SPECIFICATIONS				
Engine type	V8	V8	V8	V8
Displacement (cu. in./L)	351/5.8	400/6.6	401/6.6	440/7.2
Compression ratio	8:1	8.5:1	8.3:1	8.2:1
Carburetion	2-bbl.	4-bbl.	4-bbl.	4-bbl.
Net hp @ rpm	163 @ 3800	175 @ 3600	205 @ 3500	220 @ 4000
Net torque @ rpm	267 @ 2700	290 @ 2800	320 @ 2800	330 @ 2400
Transmission	3-speed automatic	3-speed automatic	3-speed automatic	3-speed automatic
Axle ratio	3.50:1	3.4:1	3.54:1	3.5:1
Tire make	Goodyear	Uniroyal	Firestone	General
Tire type	Polyglas Custom Power Cushion	Steel-Belted Radial	Steel-Belted Radial 721	Scrambler LT
Tire size	L78-15	LR78-15	HR78-15	10-15 LT
Steering	Power	Power	Power	Power
Overall steering ratio	24:1	17.6-13.1:1	13-16:1	24:1
Turns, lock to lock	4.0	3.3	3.25	4.3
Turn diameter (ft.)	35.4	39.0	38.4	36.9
Front suspension	Monobeam, leaf springs, quad shocks, stabilizer bar	Rigid axle, leaf springs, stabilizer bar	Rigid axle, leaf springs, stabilizer bar	Rigid axle, leaf springs, stabilizer bar
Rear suspension	Rigid axle, leaf springs, rear stabilizer bar	Rigid axle, leaf springs	Rigid axle, leaf springs	Rigid axle, leaf springs
Brakes	Power disk/drum	Power disk/drum	Power disk/drum	Power disk/drum
Brake swept area (sq. in.)	377	348	327	336
Fuel tank (gal.)	32	31	21.3	24
Liftover height (in.)	32.3	30.5	29	28.5
Curb weight (lbs.)	4664	4306	3877	4112
F/R weight distribution (%)	54/46	56/44	NA	57.6/42.4
Basic price	$6543	$5986	$6129	$6030
Price as tested	$10,765	$10,365	$9408	$8989
Major options on test cars	Ranger XLT interior ($668), AM/FM/CB ($315), skid plate ($62), automatic transmission ($197), power steering ($211), air conditioning ($554), tilt wheel ($72), fold-down rear seat ($186), sliding windows ($167), aluminum wheels ($304), 32-gal. tank ($91), rear stabilizer bar ($25), quad front shock absorbers ($74), limited slip rear differential ($175)	Power steering ($207), styled wheels ($108), HD suspension ($36), AM/FM radio ($167), steel-belted radials ($273), air conditioning ($550), oil cooler ($86), folding rear seat ($264), 400 CID engine ($465), automatic transmission ($345), Cheyenne equipment ($781), convenience package ($221)	"S" package ($595), 401 CID V8 ($475), automatic transmission ($366), power steering ($212), fuel-tank skid plate ($60), tilt wheel ($72), AM/FM/CB stereo ($349), extra-heavy-duty suspension ($115), HR78 tires ($205), power tailgate ($69), deluxe cargo-area trim ($70), front stabilizer ($29)	440 CID engine ($479), automatic transmission ($351), air conditioning ($554), AM/FM/CB stereo ($446), tilt wheel ($72), cruise control ($103), special seats ($155), sport package ($613), power steering ($212), spoke wheels ($273), off-road tires ($243), tire carrier ($67)
TEST RESULTS				
Acceleration (sec.)				
0-60 mph	14.9	12.8	11.5	11.6
25-70 mph	18.1	14.4	12.8	13.6
Brake test (cool) 60-0 mph				
Stopping distance (ft.)	148	149	124	150
Pedal pressure (lb.)	110	140	120	100
Disk temperature (°F)	135	135	128	150
Brake test (hot) 60-0 mph				
Stopping distance (ft.)	149	182	129	157
Pedal pressure (lb.)	130	140	170	130
Disk temperature (°F)	505	465	395	530
Interior noise @ 60 mph (dBA)	71	74	72	79
Handling test (mph)	53	54.5	56.3	53
Maneuverability (mph)	25.3	26.8	24.6	24.6

TEST CONDITIONS: Ambient temperature 52° F; relative humidity 65 percent; barometric pressure 30.2 inches
*Bucket seats

Performance comparison with selected models

	1974 Chevy Blazer in-line 6	1974 Jeep Cherokee V8	1974 Plymouth Trailduster V8	1973 International Scout V8	1973 Ford Bronco V8	1978 Ford Fairmont in-line 6
Mpg (city driving)	11	11	9	10	10	19
Acceleration 0-60 mph (sec.)	25.8	15.6	12.1	16.4	15.5	15.5
Brakes 60-0 mph (hot) (ft.)	162	171	199	196	179	155
Handling (mph)	58.2	56.3	47.2	60	53	62.4
Maneuverability (mph)	23.9	25.3	23	24.6	25.7	28.1
Noise @ 60 mph (dBA)	73	73	75	75	78	69

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These are the weeks when thirty minutes with your spreader and our Turf Builder® will help you get the most out of Spring's good growing weather.

This is one of the easiest tasks a good lawn calls for. You can do it the same morning you have a golf date and still tee off on time.

It's also one of the best things you can do to make your lawn thicker this Spring. The sun's moved far enough north now to warm up the earth and your grass is trying its hardest to grow.

But this is where nature needs some help. There's a desperate competition for food among the roots your lawn already has. Your soil alone can't come up with the nutrition all those grass plants need to branch out and form new plants.

A half hour with our Turf Builder and your plot will thicken.

Food is what Turf Builder gives it. Nitrogen, mostly, but phosphorus and potassium, too. Just one pass around your yard will help grow thousands of new grasses in less than a month.

And the exclusive way we make Turf Builder gives your lawn not just a quick feeding but also a prolonged feeding for up to two months.

We put this fertilizer up in tiny granules which provide a balanced mixture of plant nutrients, including both soluble and insoluble nitrogen. Rain or watering releases the soluble food right away. The insoluble food is then released slowly by organic action in your soil.

(This also keeps Turf Builder from burning your lawn. Just do what it says in the directions. In fact, you could accidentally put on four times too much this Spring and it still wouldn't burn.)

Turf Builder feeds a larger area of lawn steadily for up to 2 months.

We make a different Turf Builder for different parts of the country. We've done research all over, from the West Coast to the Northeast, to make sure you get what's best for where you live.

You can also get some free advice from the Scotts® Lawn Pro™ who lives in your area. He's a local expert and you only pay for what you buy.

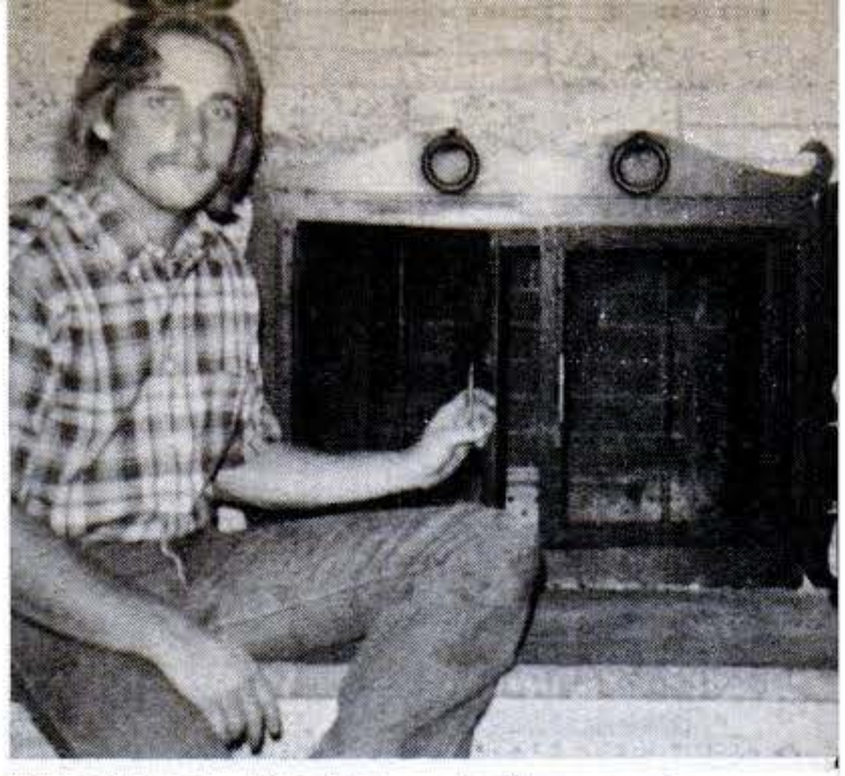
We'll give you his address if you call us toll-free: from east of the Mississippi 800-543-1415. West, 800-543-0091. Or if you call from Ohio, 800-762-4010.

And if you ever come by Marysville, Ohio, drop in. Take a look at our lawn.

ADVENTURES IN ALTERNATE ENERGY

A monthly sampling of projects PS readers have devised to conserve or replace fossil fuels

Don L. Washburn: Circulating fireplace uses outside venting



Washburn fireplace features glass doors for better air control. Outside combustion air enters through perforated box just behind inventor's knee in photo.

By EDWARD MORAN

Woodburning fireplaces and stoves are regaining popularity as major sources of home heating in a time of scarce fossil-fuel supplies. In the past three years, several projects featured in this column have made use of wood, a plentiful and renewable resource [PS, July '75, March and Nov. '76, Sept. '77].

This month's system is by an Oregon homeowner who supplements his conventional natural-gas heater with a fireplace modification that combines two ideas—outside venting and a heat exchanger with circulating blower. Don Washburn's project is easily adaptable to masonry fireplaces, and can be built with a small investment in time and materials. (Washburn spent roughly $125.) Basic welding skills are required to fashion the heat exchanger with its heat fins.

"Our fireplace was like many others," Washburn said. "The hotter the fire, the colder the back bedrooms became." A common problem, since most fireplaces draw combustion air from the home's living area—*warm* air that has already been heated by other fuels. Outside venting [PS, Feb. '76] counteracts this heat loss by bringing in combustion air from outdoors, or from an unheated area such as a garage or basement. Washburn modified the back of his firebox to accept combustion air from his garage through a perforated steel duct.

Continued

This '78 Winnebago gives you two extra feet of comfort. At no extra cost.

Last year, our lowest-priced full size motor home measured 21 feet in length. This year's Brave 23RG is actually two feet longer, several inches wider—but still at the same low price!

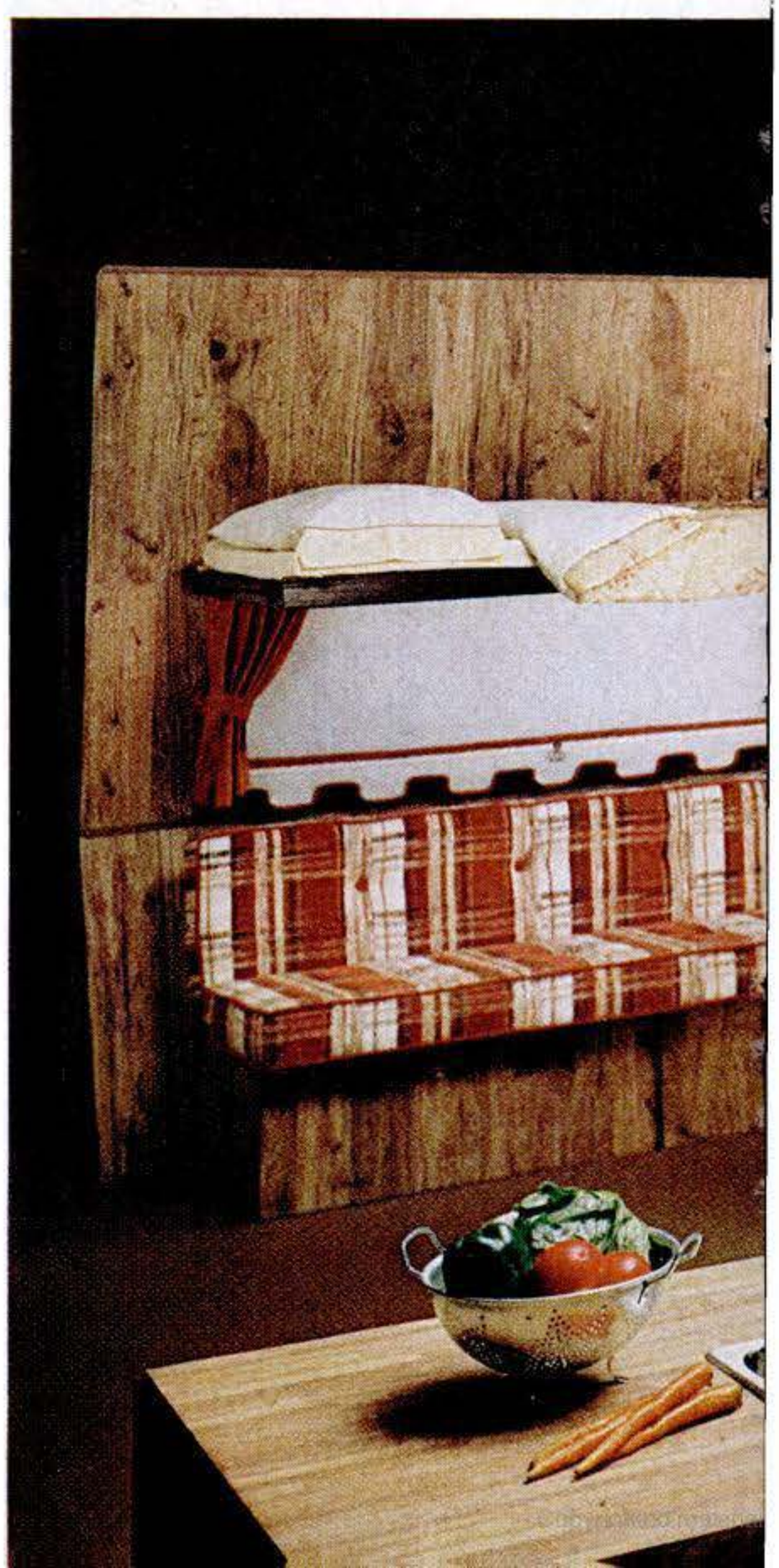
This thrifty new Winnebago isn't just bigger, it's better. We put that extra space to very good use. To give you a bathroom with separate shower compartment. Larger galley with double sink and backsplash plus more cupboard space. A choice of three forward seating arrangements: standard dinette, lounge chairs and table, or couch with pedestal tables.

Other added values include a rear fold-down bunk, AM radio, window screens for driver and passenger, and more. All wrapped up in a sleek new streamlined exterior. And all of it, remember, for no more than last year's list price.

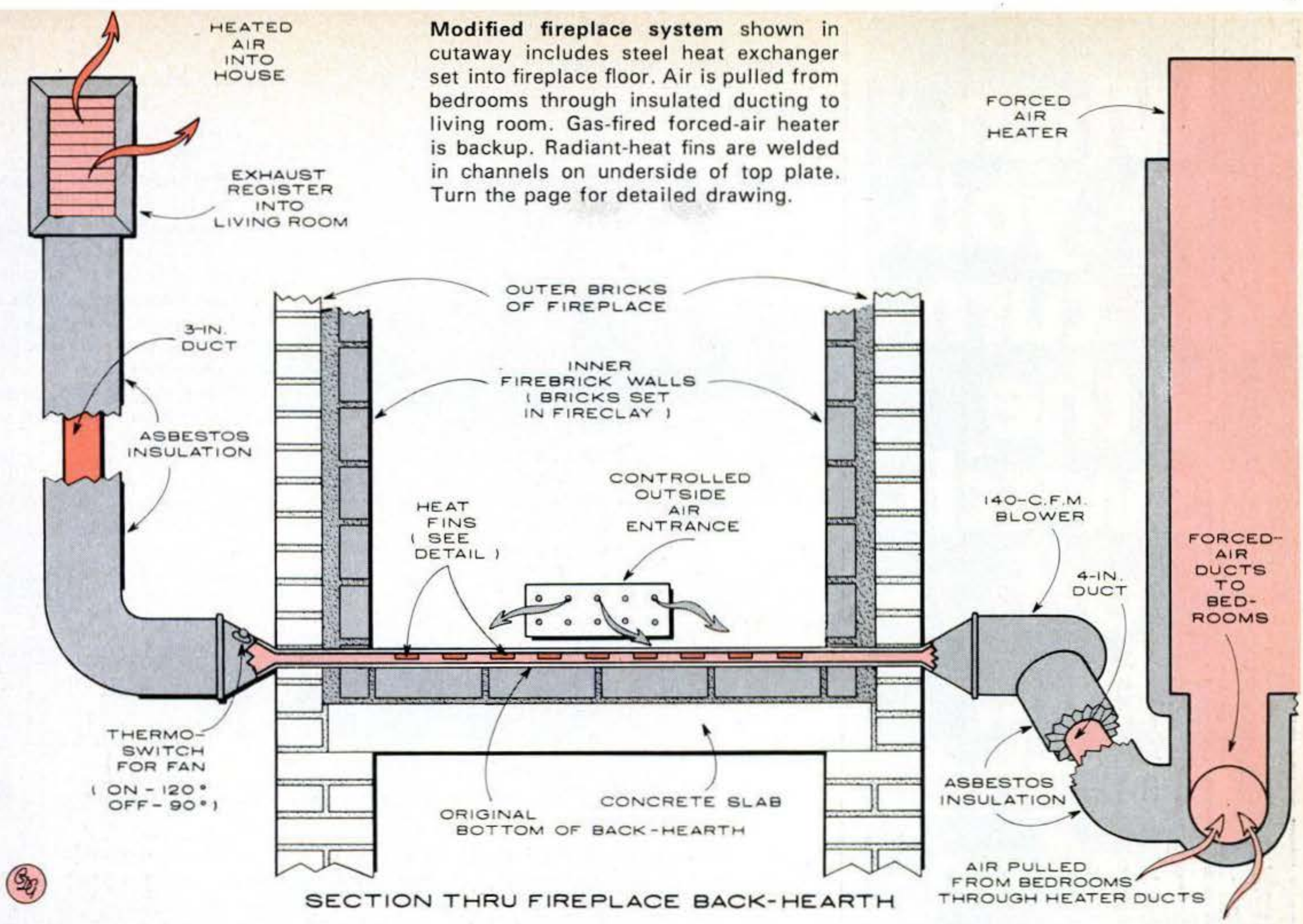
This year, value is the word for every Winnebago from the compact Minnie Winnie to the long, luxurious Elándan II. Look up your nearest Winnebago dealer in the Yellow Pages and go see him now.

You can drive a bargain with us.

There are a lot of reasons why you'll sleep better in a Winnebago.



Modified fireplace system shown in cutaway includes steel heat exchanger set into fireplace floor. Air is pulled from bedrooms through insulated ducting to living room. Gas-fired forced-air heater is backup. Radiant-heat fins are welded in channels on underside of top plate. Turn the page for detailed drawing.



SECTION THRU FIREPLACE BACK-HEARTH

Want to try before you buy? Call Rent-A-Way Winnebago. 800-447-4700 for information (In Ill. call 800-322-4400).

When you turn the switch off but, not the engine.

Carbon deposits in the combustion chamber can cause an engine to continue running after the ignition switch is turned off.

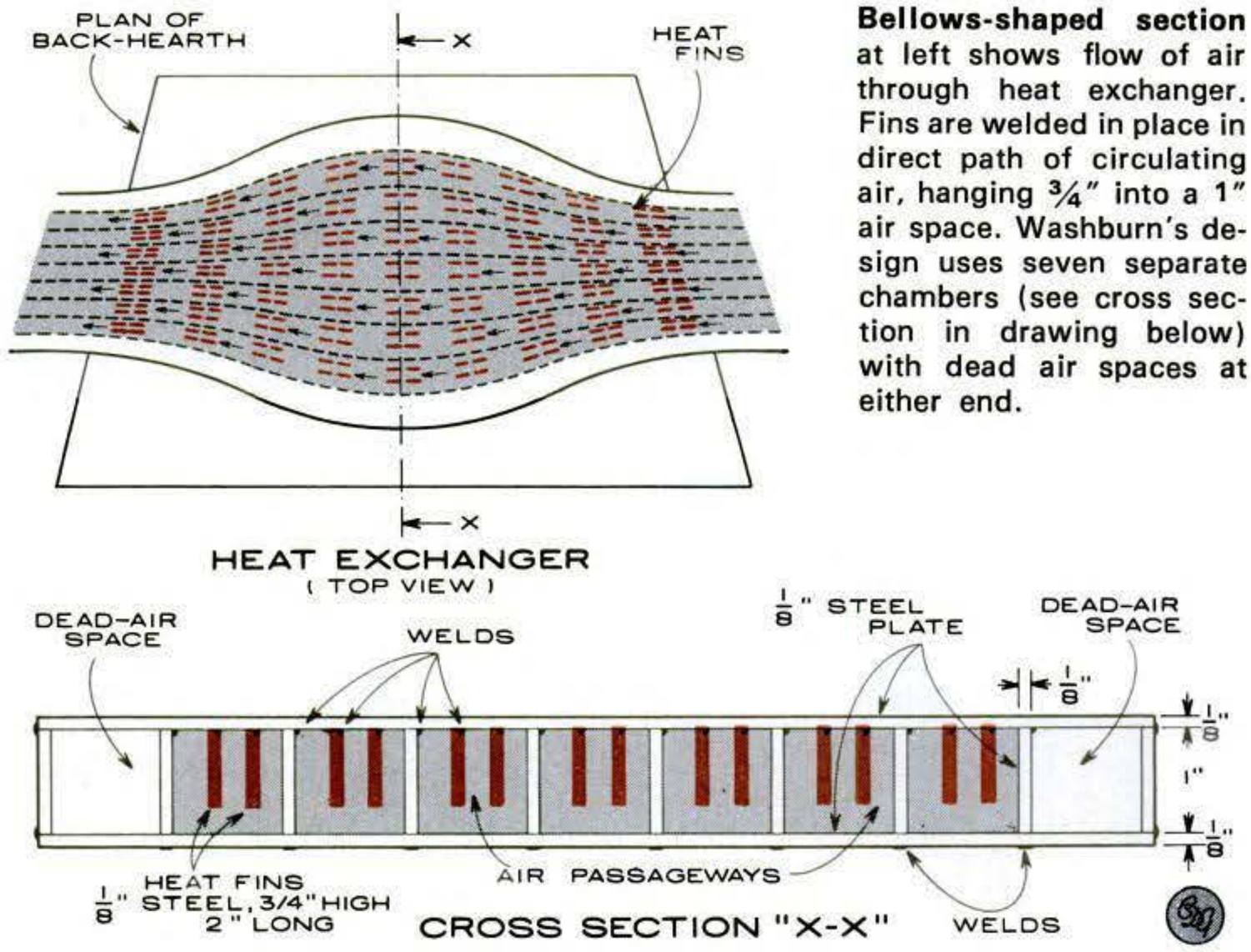
Fuel Mix helps get rid of this carbon and at the same time lubricates and frees sticky valves and thereby increases compression.

Use Fuel Mix every thousand miles and your engine will do what you want it to do.

PENNZOIL COMPANY
GUMOUT DIVISION • CLEVELAND, OHIO 44104

Circulating fireplace

[*Continued*]



Bellows-shaped section at left shows flow of air through heat exchanger. Fins are welded in place in direct path of circulating air, hanging ¾″ into a 1″ air space. Washburn's design uses seven separate chambers (see cross section in drawing below) with dead air spaces at either end.

The welded-steel heat exchanger beneath the fireplace floor is the heart of Washburn's system. A thermostatically controlled blower channels air through insulated ducting into the section of the firebox where the air can be heated most effectively. Washburn noticed that hot coals tended to collect at one spot on the floor, so he built the finned heat exchanger at that spot (see sectional diagram). Depending on the type of wood and size of the fire, he reports an output of 18,000 to 27,000 Btuh. When he insulated the ducts with asbestos, output temperatures were increased 15 percent.

The presence of air on the thermo switch (see drawing) automatically turns on the blower, sending air into the exchanger to pick up heat from the radiant fins. It then flows into the living room through a wall register. Rate of air flow is 140 cubic feet per minute. Air temperatures as high as 250° F have been recorded at the register. As night falls, Washburn closes the glass doors, damping off all house air, and controls the fire completely by the damper behind the fireplace. He estimates that these methods have saved $30-40 a month—about two-thirds of his heating bill.

The heat exchanger has been in use for five years with no structural problems. The top and bottom are made of ⅛″ steel; the channels and border of 1″-by-⅛″ flat bar; and the heat fins of ¾″-by-⅛″ flat bar steel. Washburn suggests the following method to prevent warping.

Cut the top plate ¼″ under size to allow for expansion. Tack-weld it down to a larger metal table, and draw the air-flow pattern as a guide for tacking down the channels and border. Start welding in an alternate pattern of about 4″ lengths, taking care to cool down each weld with water before continuing with a complete weld. When welds are complete, chip and wirebrush them clean. To make the heat fins, cut 2″ lengths out of the flat bar and weld them down on the channels, again taking care to cool after each weld.

Washburn reports he is now working on an air-cooling system for his home in combination with a heating system using solar energy and a freestanding fireplace. To ask a specific question, send a stamped return envelope to Don C. Washburn, 1402 Moon Terrace, Medford, Ore. 97501. PS

Your idea may bring you $200

Each month, we'll present a project developed by a PS reader and pay the inventor $200. Ideas not suitable for this series might be purchased at regular rates for use elsewhere in the magazine.

To enter, send us black-and-white glossies (one photo should show you demonstrating your device) plus pertinent text and sketches. Write your name, address, and Social Security number on each item. No material can be returned unless you enclose a stamped, self-addressed envelope.

Since space won't permit us to present projects in detail, we'll expect inventors to answer any reasonable query from readers if it's accompanied by a stamped envelope.

Mail entries to Energy Adventure, Popular Science, 380 Madison Ave., N.Y., N.Y. 10017.

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"A skill is the art of knowing what you're doing. I always liked to tinker with things, rebuild engines, work on my bike. When I joined the Army, I became an Automotive Repairman. Here's the first place I ever saw a Detroit diesel—or had good tools. In the Army, you have to work on all different things. You're expected to think for yourself a lot, but there's always somebody there to help you. They teach you to get your skill down pat, no doubts in your mind. Dad called the other night. He'd like me to work on his car."

SP4 Jim Meinzer, Ft. Riley, Kansas

Join the people who've joined the Army.

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LOOK AND LISTEN

By WILLIAM J. HAWKINS

Two-way TV

If you live in Footville, Wis., your telephone may never be the same. The Footville Telephone Co. is awaiting FCC approval to use a new high-quality audio and video system designed by 3M called CS².

Besides standard phone calls, the system allows a two-way exchange of video information. Push a button and you get a TV readout of books from the local library, stock-market analysis, medical reports, business and farm news, weather forecasts, and more. A hard copy of the TV screen data is available, too. The system is capable of sending as many as 30,000 pages of text daily. Burglar, fire, and panic-button alarms can also be tied in for remote monitoring of your home.

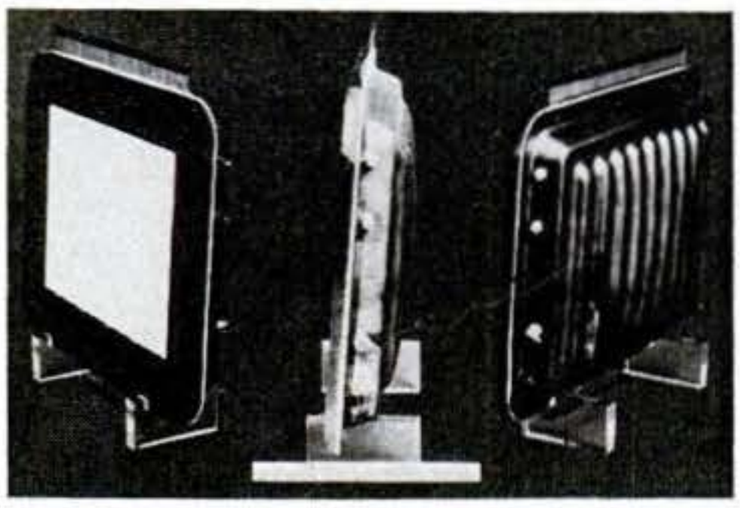
The $1.4-million project requires just one ½-inch coaxial cable to wire the community to the system. All the data, sent in digital form down the coax, is handled by equipment located in the phone company office, and this is basically why the whole idea has come off the designer's breadboard into a practical scheme. For a cable system to be economically practical, 30 or more homes per cable mile are required. (That's why Bell's Picturephone and most cable TV companies are only in the big cities.) In rural areas our country averages just five subscribers per mile. But since the CS² will be run with the present working phone system, this cost is dramatically reduced to the point where it becomes practical.

Presently, the FCC bans a phone company from owning a CATV system. The Footville company is hoping for a relaxation of this rule in rural communities. (A similar system, called Viewdata, is operating in Britain and we will be covering it next month.)

Computer in a briefcase?

Look at any home computer: The biggest space needed is for the TV-display picture tube. Without it, a home computer could be basically built on a flat printed-circuit board with a standard calculator keyboard fitted with typewriter keys. Now look at this flat display from Texas Instruments.

Just two inches deep, this new ca-

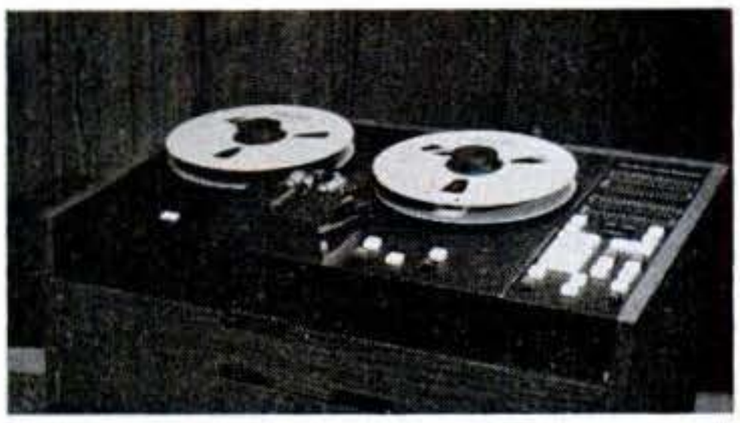


thodoluminescent display is designed for alphanumeric display. Using a 5X9 dot matrix, its display field is set for 23 lines of 80 characters each—bettering many of the standard terminals used now. TI won't get involved with home computers, you say? Rumor has it that the company already has one.

Digital audio

In the very near future, we'll see an abundance of home audio systems that use digital techniques for processing sounds off tape or records [see "Digital HiFi and TV, page 50]. In most cases the original recording will be done in digital—on tape machines like this 3M/BBC Digital Audio Mastering System.

The electronics in this tape transport convert the sounds being recorded into a digital stream of on-and-off



bits. Added to it is another digital "word" to check the accuracy of the recording. The master tape can then be reproduced on a tape or disc and the copy is as flawless as the original.

Goodbye, Cinerama?

According to a study done by A.D. Little Inc., skyrocketing sales of VCR's, discs, and projection-TV systems will make the corner movie house obsolete by 1985. Probably that projection was made before RCA's and MCA's announcement of "redesign" for their disc systems. On-sale date has been put off again—it's now around this fall. VCR's continue to be strong, however, with GTE Sylvania announcing their four-hour deck and Sears setting up national distribution for a BetaVision two-hour machine that's expected by the middle of this year.

Meanwhile, at least one person is putting the laser and disc combination to work. William Heine, of Palo Alto, Calif., is using the laser technique to extract audio info directly off standard records. Old platters can be played back, too. And, with the nicks and scratches out of focus, the old recordings come out sounding like new.

Wireless cassette

Anyone can dub out commercials when recording music off the air—just get up and flip the pause switch on the tape deck. But it's the getting-up part of the operation that bothered Fisher Corp., so, they've come up with a wireless remote-controlled tape deck CR 4025. Price: $249.95.

A PS P.S.

If you're looking for Maxell recording tapes for your cassette recorder, use caution when picking it off the shelves, a company spokesperson warns. A package of *Maxelite* tape may look the same (it's purposely designed to at a quick glance) but it is not from Maxell and is not, the company says, the same quality. PS

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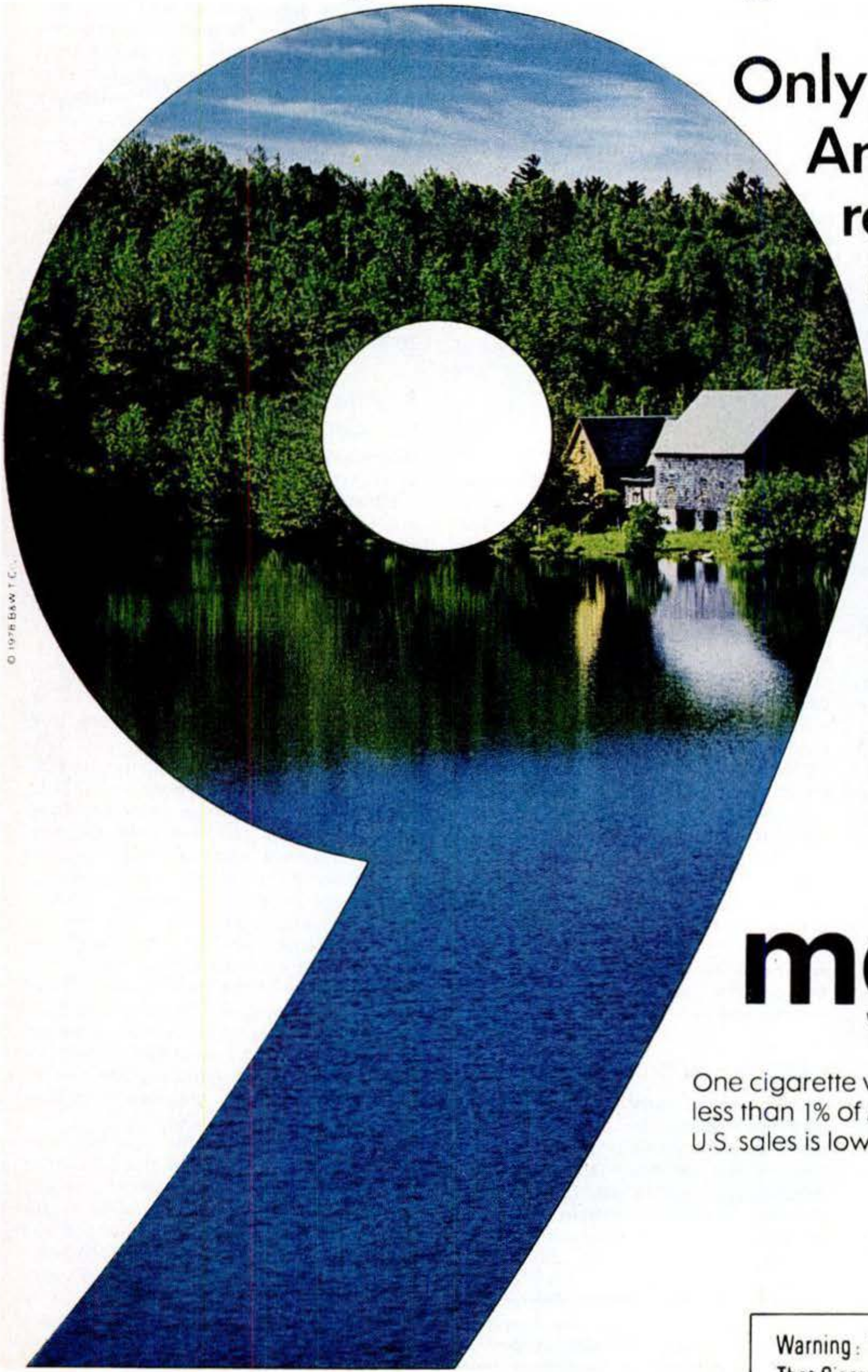
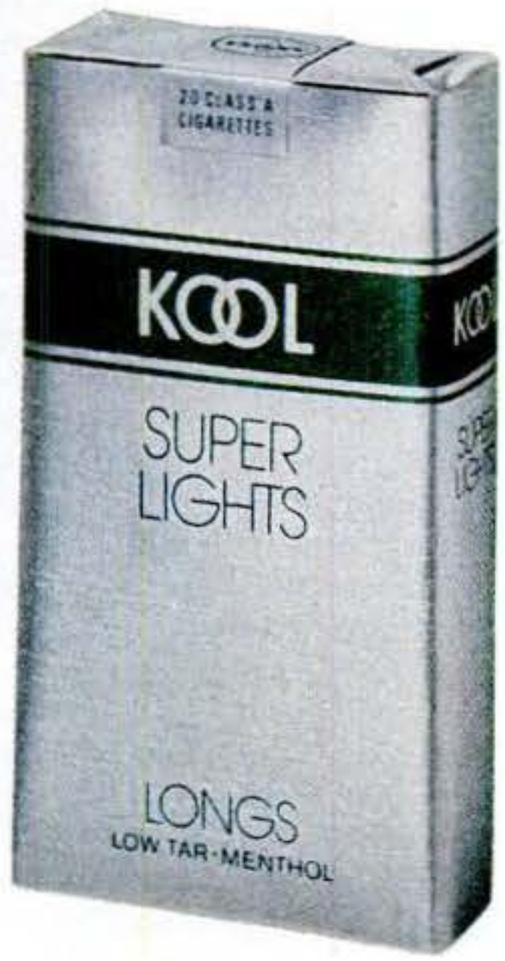
KOOL SUPER LIGHTS LONGS

No leading Menthol Long is lower in 'tar.'*



Only 9 mg. 'tar.' And KOOL's refreshing satisfaction, too.



9 mg. 'tar'

One cigarette which made up less than 1% of Menthol Longs U.S. sales is lower in 'tar.'

9 mg. "tar," 0.8 mg. nicotine, av. per cigarette, by FTC method.

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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DETROIT REPORT

By JIM DUNNE

Out-smalling GM

Ford's 1979 big-car lines, including the LTD and the Mercury Marquis, will get smaller next year. Ford and Mercury wheelbases will shrink from 121 inches to 114. About 18 inches in length will be lopped off both cars. The changes will make the top Ford lines slightly smaller on the outside than the GM full-size lines, and with the accompanying weight reduction, fuel economy will improve by an average of up to three mpg. Styling themes of the past will be carried over, including long hoods and decks. Grilles similar in appearance to those of present cars will also be used. Yes, the change will make the full-size Ford lines smaller than the intermediates, but it's a marketing conflict that Ford will have to live with for one year until the intermediates shrink.

Corvette gets a four

Chevrolet plans to bring the Corvette up to 27.5 mpg by 1984 in two steps. First, the 350-cu.-in. V8 engine will be dropped in 1980, and the 305 V8 substituted. Essentially the Corvette will use the same chassis then that it does now. In 1983, the 305 will be dropped, and a four-cylinder engine—probably a turbocharged version of the Pontiac 151-cu.-in. engine —will be used. At the same time the four is introduced, the Corvette's body and chassis will be completely redesigned. Power-train details are still to be decided, but the weight of the 1984 'Vette will be 2500 pounds, vs. 3500-plus for the 1978 car. The combination of the turbocharged four-cylinder and the drastic reduction in weight will give the two-seater a performance as good as or even better than the present model's.

Even more diesels

There's a diesel epidemic at GM. Car divisions are working on at least three diesel versions of gasoline engines. The three closest to production are the Pontiac 151-cu.-in. ("Iron Duke") four, the Olds 260-cu.-in. V8, and Buick's 231-cu.-in. V6. The engines are expected in the 1979 model year. They will sell at a premium—but not as much as the $850 of the Olds 350-cu.-in. V8 diesel. Fuel-economy improvements will be substantial. The Pontiac engine will boost the Sunbird up into the 40-mpg range for highway driving, while the Buick V6 in diesel version will push the Century into the 35-mpg highway category.

Ford mini-motors

Ford's smallest engine is now the Pinto 2.3-liter four, but plans are being made for the introduction of two small engines of 1.3- and 1.6-liter displacement (80 and 98 cu. in.). They are part of a program to bring out a line of domestically built small front-wheel-drive cars to replace the Pinto in 1981. The models are designed to be the most fuel-stingy that Ford has ever built. The engines may feature aluminum heads as part of a weight-cutting diet Ford is imposing on its smallest models. This will mark the first time that the lighter metal has been used in a domestic Ford engine. Up to now Ford has resisted all attempts to replace iron in its engine blocks or cylinder heads.

Bye-bye big blocks

Engine designers working on the power plants that must meet the government's 27.5-mpg target by 1985 say that there will be lots of changes in future engine lineups.

The biggest Chrysler V8's, the 440- and 400-cu.-in. motors, will be phased out of production this summer, leaving the 360-cu.-in. engine as the top power plant in Chrysler's stable for 1979. Chrysler will shrink the Newports, New Yorkers, and the resurrected Dodge Royal Monaco next year, so the 360 V8 will give all the performance needed in those models.

Ford insiders say that the 351-cu.-in. V8 will be the company's biggest engine in 1983. The 400 and 460 now used in Lincolns, Fords, and Mercurys will be dropped. With the lighter cars planned by Ford, the power of the bigger V8's will not be needed. Power-to-weight ratios—which determine acceleration—will remain the same even though engine size will shrink.

AMC lineup expands

AMC plans no cutbacks in small-model offerings, despite the poor sales record of its automobile lines in recent years. Instead, the company is determined to expand its model lineup. Luxury will be stressed, thanks to positive experiences with the Concord. A luxury Jeep Wagoneer that features leather upholstery is part of the plan. Luxury versions of the Gremlin will also debut. The next big model improvement is a new Gremlin in '79. It will have a more modern appearance, greater rear seat room, lighter weight, and greatly improved fuel economy. The future of the Matador series, however, is in doubt.

Dasher look-alikes

The 1979½ GM compacts look much like the current VW Dasher. Bodies feature sharply defined sheet metal, with flatter fenders and a six-window fastback roofline. At the rear of the four-door models is a hatch opening instead of the normal trunk lid. The cars are radically different from the present compacts—Nova, Phoenix, Omega, and Skylark. Grille and taillights are the only recognizable remnants of the 1978 styles. The Nova has an egg crate texture grille that is flanked by single rectangular headlights, similar to the present Malibu. Bodies are smaller, but thanks to clever design, the interiors are just as roomy as today's compacts. Wheelbases will shrink from the present 111 inches to 103½. Weight is reduced an average of 500 pounds. Best of all, the front-drive cars will have an overall length of about 175 inches, two feet shorter than present cars. New engines, including a 60-degree V6 of 165-cu.-in. displacement, will be part of a drive train designed to deliver up to 30-mpg average.

Seville goes FWD

The next major change for Seville is planned for 1980. The car will get the same front-drive system that is being readied for the 1979 Eldorado. Basically, it will be a four-door version of the Eldorado, but with a longer wheelbase and a lot more rear seat room. For the first time the two Cadillac super-luxury models will share the same basic body, GM's A shell.

New pony cars

Ford will bring out new Mustang and Capri models for 1979. The cars will be completely restyled, and for the first time, the Capri will be built in the U.S. (Until now it was imported from Ford of Europe.) For the first time the two sporty cars will share the same chassis and many body panels. Styling differences will come from different grilles, taillights, and trim items, but the interiors will be identical. The Capri will be the most changed of the two. It will take on some of the chunky lines of the present Mustang. A special wheel-and-tire system is slated to be introduced on the cars. Made by Michelin, they provide exceptional handling and ride characteristics, but are not adaptable to present wheels or tires.

Though details on the new cars are still sketchy, it's a pretty good bet that Ford will install a turbocharged version of the 2.3-liter, 4-cylinder engine in one of the models. It should equal or exceed the performance of the 302-cu.-in. V8 also slated for the car. People who have seen the Mustang say it is one of the handsomest designs to come out of Ford in a long time, and is somewhat reminiscent of the Mercedes 450 SLC coupe. PS

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People write to PENNZOIL

Supreme Quality — Safe Lubrication

Have a question about motor oil? Lubricants? Engines? Ask the Pennzoil experts...

Dirty Questions. I have been changing the oil and filter in my 1976 Monte Carlo every 15,000 miles. After only 200 or 300 miles, however, the oil starts looking really dirty. Also, when I changed my spark plugs after 13,000 miles they all showed a heavy coating of what appeared to be carbon deposit, despite the fact that 95% of my driving is on the highways. What could be causing the dirty oil and deposit?

P.W., Cheney, Washington

Don't worry about the oil looking dirty in 200 to 300 miles. Worry if it doesn't look dirty, for that means the oil is not doing the job it is intended to do, namely, keeping the contaminants suspended in the oil so they can be drained out when the oil is changed. If the deposit on your spark plugs is carbon, this may or may not be normal for your vehicle. We suggest you ask for the next higher heat range plug, which may help keep the deposit burned off.

Pennzoil Praise. I bought my Mercury Cougar in 1970 and have used only Pennzoil Motor Oil in it. I now have over 130,000 miles on the car, and have never had any engine trouble. Even mechanics are amazed at how well the car runs. Thank you, Pennzoil, for making such a fine product!

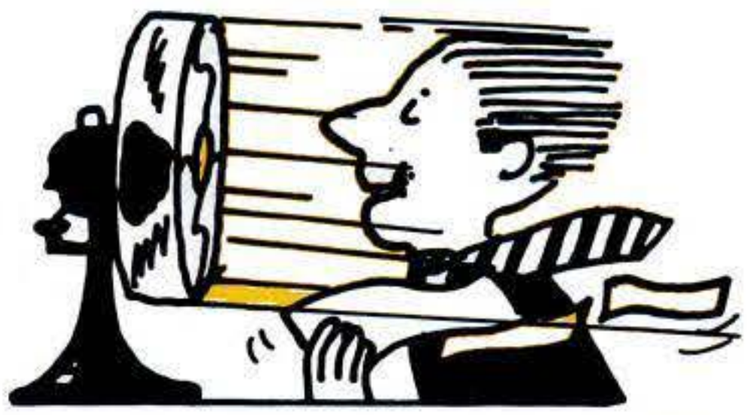
H.E.W., Barneveld, Wisconsin

Thank you for your fine comments about our Pennzoil products. Through the years, Pennzoil has endeavored to offer the finest lubricants. We believe your experience is a good example of how successful Pennzoil has been. We appreciate your letting us know.

Antique Answer. I have 2 antique autos, a 1931 Plymouth Sedan and a 1926 Model T Ford touring car and use Pennzoil 10W-40 oil in both. Will the detergent additive in this oil have any bad affects on the Model T's magneto insulation? Also, since neither car is equipped with an oil filter, can the detergent oil cause any engine damage?

R.S., Stonington, Ct.

Multi-vis or single grade detergent oils are both satisfactory for your antique autos. With detergent oils, we would expect no degradation of your Model T's magneto insulation. In addition to a detergent, Pennzoil Motor Oils contain a dispersant which helps keep particles harmlessly suspended in the oil. So it is safe to use Pennzoil 10W-40 in your antique autos, even though they have no filters.



Air-Cooled Advice. I drive a 1974 Volkswagen with an air-cooled engine. I've been using SAE 30 in the summer and SAE 20W-50 in the winter, and have been considering using 20W-50 all year. However some people have advised me not to use multi-viscosity oil in a VW. Do you agree with this?

H.Y., Santa Fe, New Mexico

The SAE viscosity recommendations by Volkswagen are somewhat different from those of other car manufacturers. They do allow multi-viscosity oil to be used, but only certain ones and only up to about 80°F. Above that temperature, only SAE 40 is recommended. For your particular area, we would suggest either SAE 20W-40 or 20W-50 during the winter months and SAE 40 during the summer.

Greasy Solution. The owner's manual for my 1970 Volkswagen specifies the use of a multi-purpose grease with a lithium base for lubrication of the front axle. Would you recommend Pennzoil Multi-Purpose 705 for this application?

J.P.L., Ambler, Pennsylvania

Pennzoil Multi-Purpose 705 is, in fact, a lithium grease and is entirely satisfactory for use in your 1970 VW. The lithium base refers to the type of solids from which the grease is made. Lithium provides outstanding mechanical and thermal stability.

Pressure Problem. I have a 1969 AMC Rebel in excellent condition and change the oil and oil filter every 4,000 miles. When I start the motor after it's been off for an hour or so, the red oil light remains on for about 20 to 30 seconds. I had the oil pump cover, sending unit and filter body replaced, but I am still having problems. What can you suggest?

M.C., New Britain, Connecticut

We offer three suggestions.
1) You may have a brief air lock in your oil lines or oil gallery. This could be due to an over-filled crankcase causing a foaming condition. We suggest you add oil only to the full mark even though it may take slightly less oil than your owner's manual specifies.
2) An air lock could have also developed after your last filter change, which prevents an immediate normal flow of oil and pressure buildup after first starting the engine.
3) Another cause could be collapsed valve lifters as a result of varnished barrels or other obstruction that prevents the lifters from pumping as they should.

WE'RE OPEN TO QUESTIONS about motor oils, lubricants, engines. But, you can tell *us* a few things, too. Maybe you have discovered something interesting about motor oils or lubricants. Or you have a special reason for being a Pennzoil fan. We would like to hear from you. Write to: Pennzoil Company, Research Department, P. O. Box 808, Oil City, Pennsylvania 16301. Note: sorry no pictures or material can be returned. Letters chosen for publication are subject to revision necessary for publication requirements.

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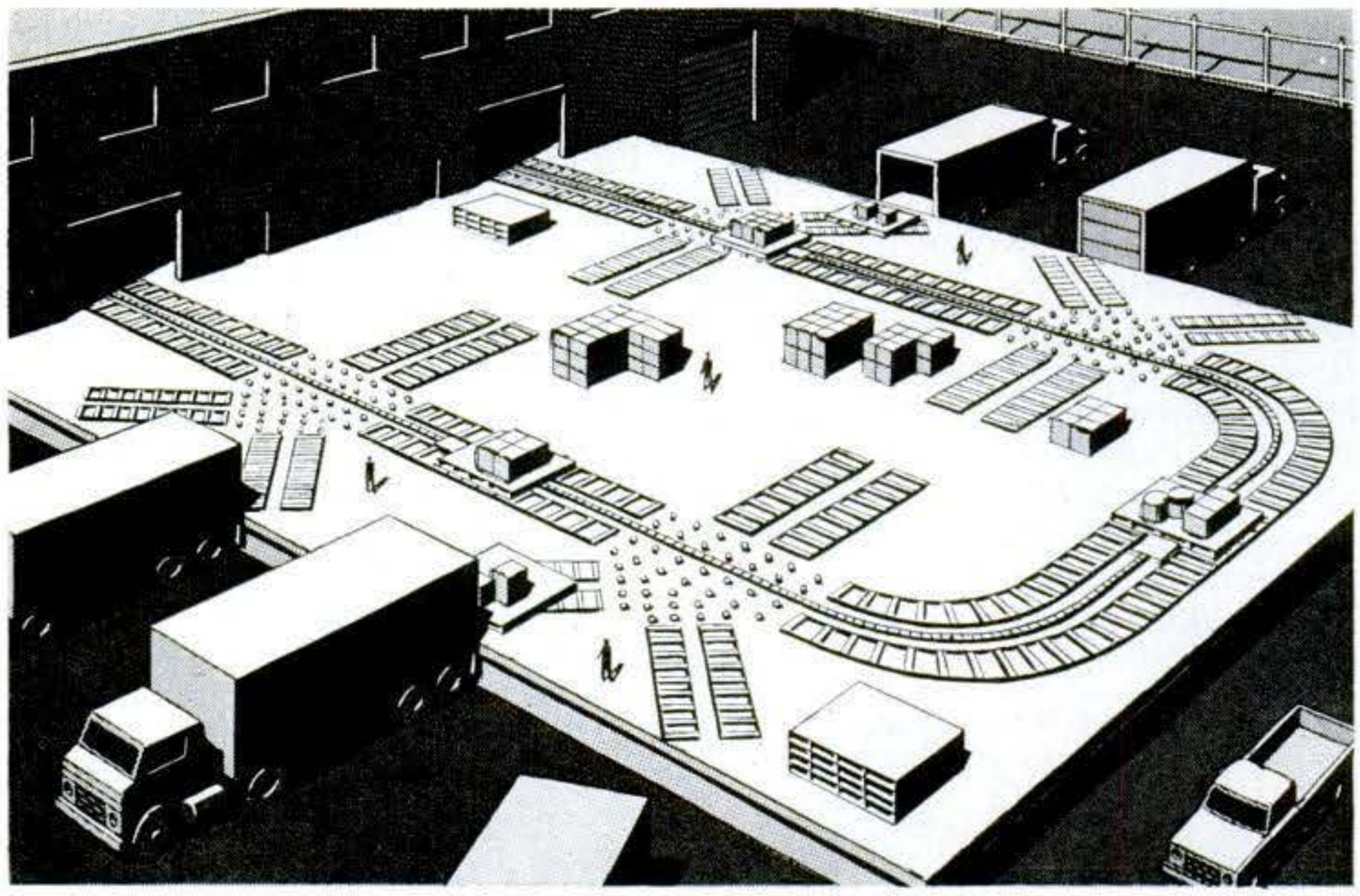
NEW IDEAS FROM THE INVENTORS

ILLUSTRATIONS BY RAY PIOCH



Roller conveyors speed freight transfer

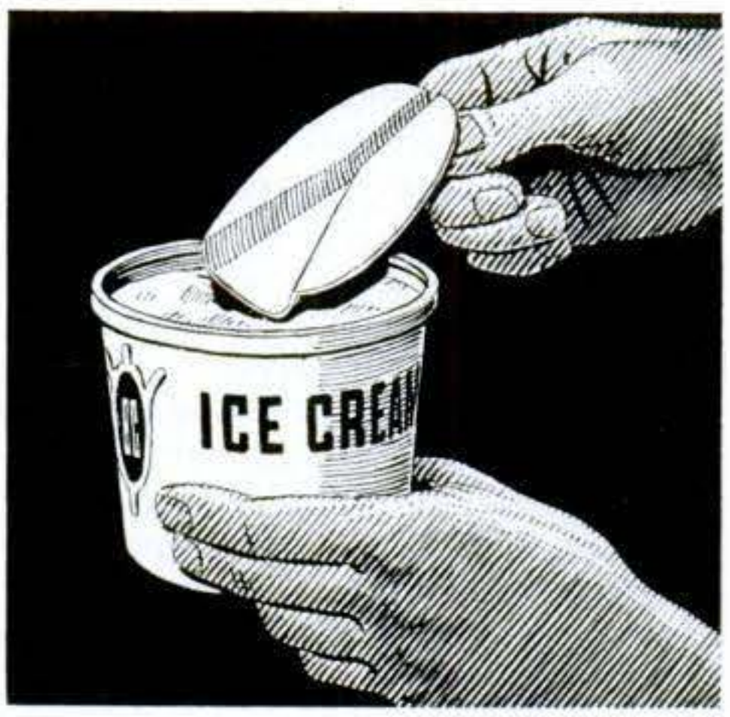
Moved along an endless conveyor chain by powered pusher arms, palletized cargo might be more conveniently shifted between trucks or in and out of warehouses. These conveyors would move in one direction only, but transfer stations, formed by rows of casters, would be spaced around the loop. At these points flats could be sided, moved in either direction, fork-lifted, assembled in truckloads, or shifted into or out of storage.

Pickup frame lifts boat

Wedged or bolted into the bed of a pickup, this extensible frame could lean back and down to ease loading or offloading of a boat. It could then be cranked up to carry the boat, flat and cradled, above the cab and body of the truck. Hauling a boat even longer than the vehicle, the loader wouldn't interfere with normal use of the pickup nor greatly reduce its cargo space.

Dropper restrains eyelid

Threaded onto the tip of a squeeze bottle containing cleansing or medicinal eyedrops, this shaped plastic finger would gently grip your eyelid and hold it open while you measured out the dosage. It would direct the drops where they were supposed to go, keep you from blinking them out of your eye before they could do their job.



Container lid forms spoon

Scored to fold easily, the stiff paperboard lid of this container could be bent by the purchaser into a handled spoon that would do a better scooping job than the flat wooden spoon now commonly provided with cups of ice cream or yogurt. And it would be less likely to split, get lost, or be forgotten at time of purchase.

Phone checks dialed number

Displaying a called number on a panel, this computerized phone would let you check your dialing accuracy and store busy (or frequently called) numbers for automatic dialing. It could also time your calls, figure toll charges, and let you work out other calculations while you talk. Used to phone a computer, it would display—or read—digital data.

The following patents have been issued on these inventions: **Loading conveyors**—No. 3,872,963 to C. Sherwood, Santa Monica, Calif.; **Eyelid restrainer**—No. 3,872,866 to J. Lelicoff, Prescott, Ariz.; **Lid spoon**—No. 3,931,925 to S. Ruff, New Rochelle, N.Y.; **Boat loader**—No. 3,872,989 to H. Smithson, Redwood City, Calif., and E. Smithson and R. Asburry, Portland, Ore.; **Phone display**—No. 3,932,709 to D. Hoff, Tiburon, and P. Young, Oakland, Calif.

Patents may be ordered, by number, from the Commissioner of Patents Washington, D.C. 20231, at 50 cents each. You may write to an inventor by name and patent number in care of the Commissioner.

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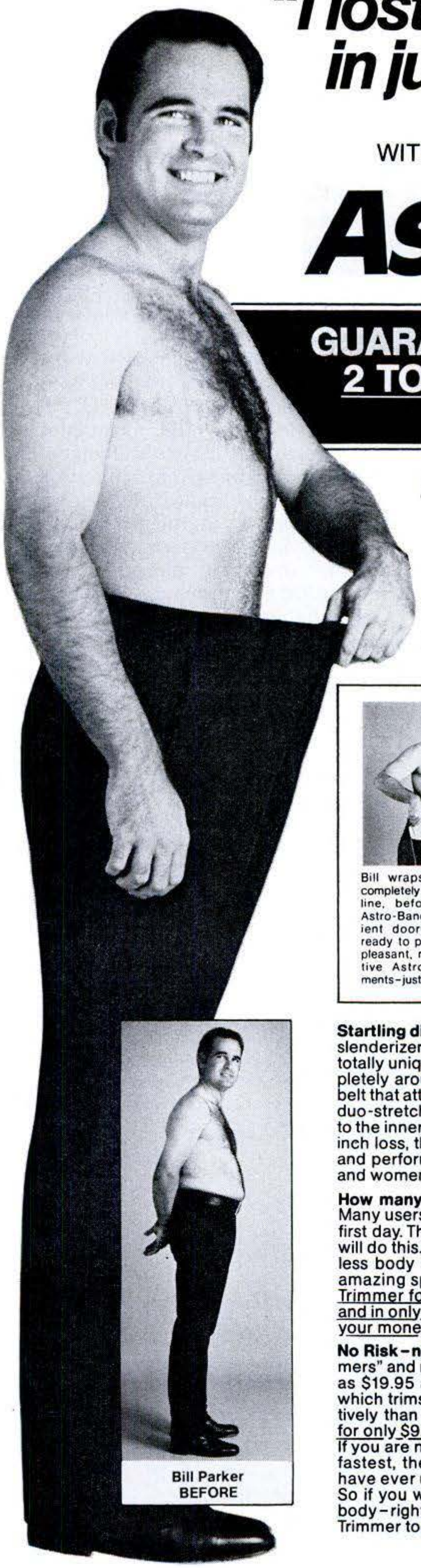
"I lost 5 inches from my waistline in just 3 days..." says Bill Parker

WITH THE MOST ASTOUNDING **WAISTLINE REDUCER** OF ALL TIME!

Astro-Trimmer™



GUARANTEED TO REDUCE YOUR WAISTLINE 2 TO 5 INCHES IN JUST 3 DAYS–OR LESS OR YOUR MONEY BACK!

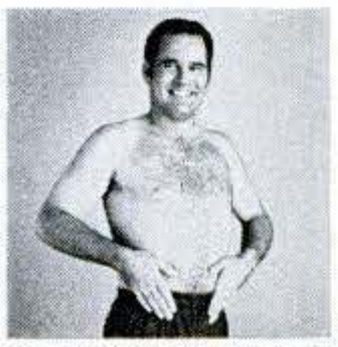
***Bill Parker** "...and it was a piece of cake–no diets, a simple ten minute program that got rid of the inches for good–and just look at the difference in my appearance! The inches have not come back–here is a product which did everything it promised–and more."*

IN JUST 3 DAYS...WITHOUT DIETING...IN JUST MINUTES A DAY...

HERE IS HOW IT WORKS:

Bill wraps the Astro-Belt completely around his waistline, before hooking the Astro-Bands to a convenient doorway. He is then ready to perform one of the pleasant, marvelously effective Astro-Trimmer movements–just about 10 minutes.

Now Bill simply relaxes a few moments with his Astro-Belt in place. His Astro-Trimmer movements have triggered the Astro-Belt's incredible inch-reducing effect which goes on working even as he relaxes.



After his brief period of relaxation, Bill removes his Astro-Belt. His waistline is already tighter and trimmer. Bill lost 2 1/4 inches on his waistline the very first day–and over 5 full inches from his waistline in just 3 brief ten minute sessions.

RESULTS LIKE THESE:

F. Masters: *"No matter what I tried – dieting, exercise – I was never able to get rid of the roll of excess inches around my midsection. Then Astro-Trimmer came along and reduced my waistline 6 full inches – from 38 1/2 to 32 1/2 inches – in just 3 days without dieting."*

T. Greer: *"My waist actually came down 5 full inches in 5 days–from 38 to 33. My entire physique looks so much better and I feel so much better that I can't praise this sensational trimmer enough."*

Bill Parker
BEFORE

Startling discovery–The Astro-Trimmer has got to be the most sensationally effective and the most fun to use slenderizer of all time. It is a marvel of ease, comfort and efficiency–and a pure joy to use. The Astro-Trimmer's totally unique design consists of a double layered belt; a soft nonporous inner thermal liner which wraps completely around your mid-section producing a marvelous feeling of warmth and support–and a sturdy outer belt that attaches you to the super duo-stretch Astro-Bands which you hook to any convenient doorway. These duo-stretch bands enhance your slightest movements and transmit their effect–greatly magnified–directly to the inner thermal liner of the belt to produce an absolutely unequaled inch-reducing effect. In fact, for sheer inch loss, the Astro-Trimmer is supreme. Try it for yourself–at our risk–just slip on the belt, hook it up, stretch and perform one of the easy-to-do movements in the instruction booklet and watch the inches roll off. Men and women from 17 to 70 are achieving sensational results from this ultimate inch-reducer.

How many excess inches can I lose with the Astro-Trimmer? How many excess inches do you have? Many users lose 2 or more inches from their waists and 2 or more inches from their abdomens the very first day. Three, four, even more inches off the waist in three days is not uncommon. Not everyone will do this. The degree of inch loss will vary with individual body response. However, this matchless body shaper melts excess inches off the waist, abdomen, hips and thighs with such amazing speed that if your waistline isn't 2 to 5 inches trimmer after using your Astro-Trimmer for just 3 days–or less–and if you don't lose these inches without dieting and in only 5 to 10 minutes a day, you may simply return your Astro-Trimmer and your money will be refunded.

No Risk–no obligation–money back guarantee. So-called "waist trimmers" and reducers are now being nationally advertised for as much as $19.95 and more. Yet the sensational new Astro-Trimmer–which trims and slims excess inches far faster, far more effectively than anything we have ever seen–is being offered for only $9.95 with a complete money back guarantee. If you are not satisfied that the Astro-Trimmer is the fastest, the most effective waist reducer you have ever used, it will not cost you a penny. So if you want a trimmer, more dynamic body–right now–send for your Astro-Trimmer today.

ORDER NOW FOR A SLIMMER, TRIMMER WAISTLINE THIS WEEK!

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Please send me ____ Astro-Trimmers along with complete easy-to-use instructions. I understand that if I do not lose from 2 to 5 inches from my waistline in just 3 days I can return my Astro-Trimmer and receive my money back. **I enclose $9.95 for each Astro-Trimmer plus .90 each for postage and handling.**

☐ **Check** ☐ **Money Order** ☐ BankAmericard ☐ Visa ☐ Mastercharge **No COD's accepted. PLEASE CHARGE TO MY:**

Charge Account No _____ Exp. Date _____

Man: waist size _____ Woman: waist size _____

Name _____

Address _____

City _____ State _____ Zip _____

PAT. PEND

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Digital hi-fi and TV

Computer-like circuits enhance audio and video

New equipment promises super-fidelity in sight and sound

By JOHN FREE

The digital electronics revolution that brought you the pocket calculator, digital wristwatch, TV games, and home computers is beginning to influence the way audio high-fidelity signals are recorded, stored, and played back, plus the television pictures you watch.

Nothing new, you say? We've been saturated with ads for computerized and digitized TV's, FM tuners [PS Nov. '77], turntables, tape decks, and other products for years. The digital circuits for these products are designed to simplify tuning, give you digital readouts of speed, channel, or frequency, and provide smoother, more accurate mechanical performance. In each case, the circuitry helps control the continuous analog signals used for audio and video.

But now engineers have developed techniques to digitize the analog audio and video signals themselves. And the improvement in high-fidelity sound is so dramatic that few hi-fi systems or listening rooms are good enough to take full advantage of digitized audio.

Some of the new devices that bring about this radical improvement will be described shortly. But first, what makes a digitized

Continued

Audio-disc player from Sony (below) provides ultrahigh-fidelity sound as a laser beam reads digitally coded signals on reflective discs. Production players will be smaller than prototype.

Dual-function players and discs under development by Hitachi (above) can play either audio or video discs. Machine is first to use a tiny semiconductor laser, which simplifies construction.

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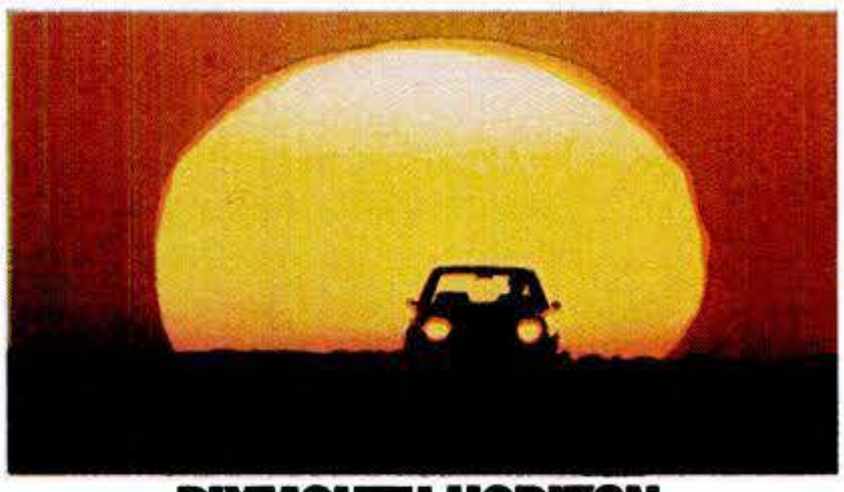
DISCOVER A NEW HORIZON.



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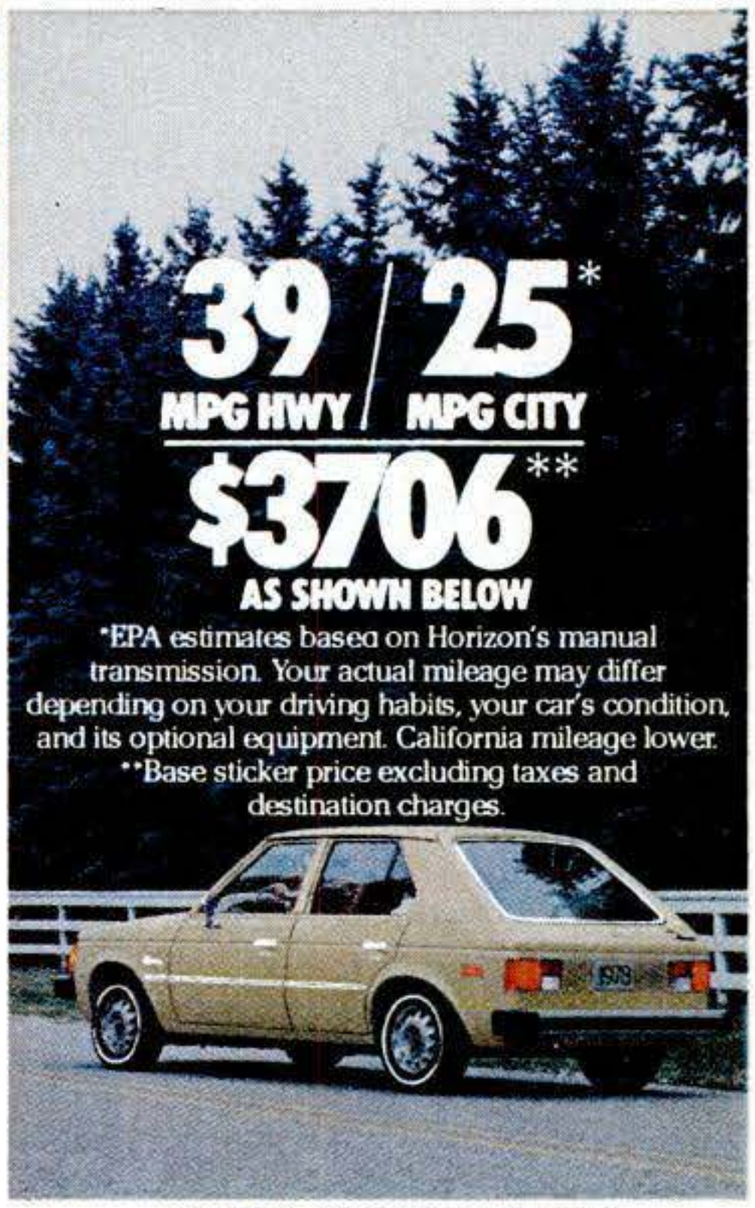
Horizon is stingy on gas. But it's generous on comfort and confidence because of front-wheel drive, tuned suspension and rack and pinion steering.



COMFORT

Horizon is loaded with comforts. Like a variety of seating options. And such standard comforts as cut pile carpeting and color-coordinated interiors.

SNOW, WIND, RAIN

Horizon gives you outstanding handling and traction in all kinds of weather because it's the first American car of its size with front-wheel drive.

PRICE/ECONOMY

Price includes front bucket seats, AM radio, whitewall radial tires —many things not standard on other cars of its type.

FOUR BIG PEOPLE

Horizon is so roomy, four six-footers can relax in comfort front and back. And there's still room for luggage.

NEW PLYMOUTH HORIZON

Horizon is a new answer for a changing America. An America concerned about energy and inflation. Horizon gives you four doors, fold-down rear seat and hatchback to make it easy to pack luggage. Horizon even offers the option of automatic transmission along with stereo, roof rack and sporty trims.
By any standard of room, ride, comfort, style, price and mileage, Horizon is uniquely suited to today's times and needs.

WHEN YOU WANT TO GO ANYWHERE IN COMFORT AND CONFIDENCE.

RELAX. PLYMOUTH HORIZON CAN HANDLE IT.

You can buy or lease the new Plymouth Horizon at your Chrysler-Plymouth dealer.

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[*Continued*]

signal so much better than the continuous analog electronic signals from discs, tape, and other sources?

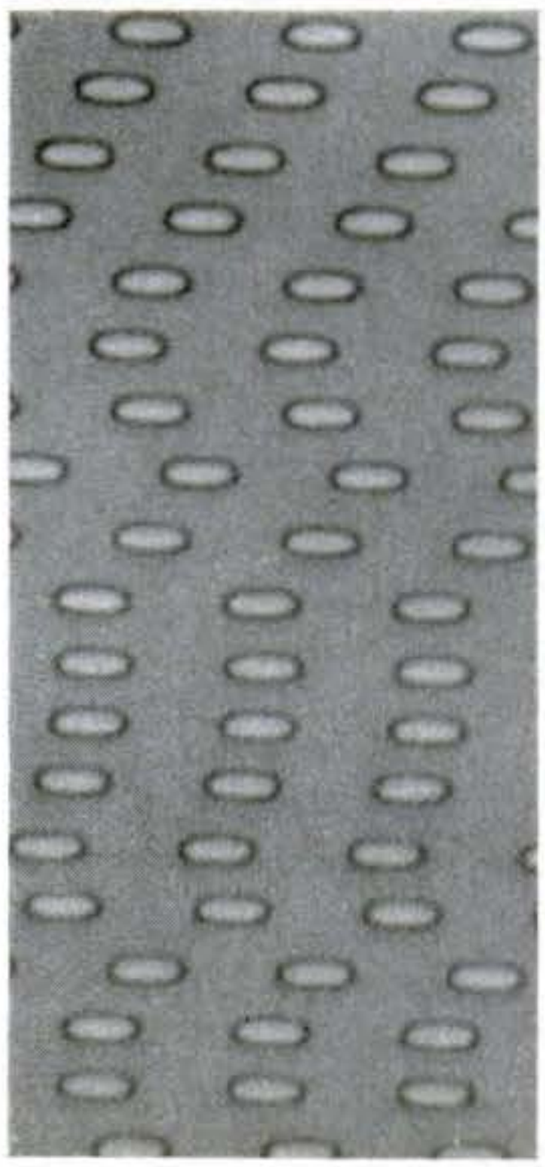
One factor is that analog signals constantly change in amplitude and frequency. Weak, low-level analog signals can be drowned out or distorted by noisy storage mediums (tape hiss) or during transmission (snowy TV pictures). Both low- and high-level signals may have their amplitudes and frequency characteristics distorted by amplifiers.

Coded signals

Digital signals, however, are simply a series of on-or-off, constant-amplitude pulses. The order of these pulses can be arranged (coded) to represent any analog signal converted into a digital format. But most important, the circuits used to convert digitized signals back into analog form will only recognize properly coded pulses. Noise, such as tape hiss, is ignored and you don't hear it.

Moreover, digital signals are far less susceptible to distortion during transmission. And even if the signal is distorted, if the digital decoder can recognize the on-off pulse sequences, it can still recreate an analog signal that's audibly or visually identical to the original.

Recording/playback adapter (left) for Sony's or other video-cassette recorders puts digitized audio signals on the cassette-tape tracks that normally store video signals. Fidelity exceeds that of nondigital professional recorders.



Optical disc-player system made by Mitsubishi and others has a dynamic range exceeding 98 dB. Spiral tracks of pits on discs (magnified at right) are about 0.6 microns wide, have a protective plastic coating against dust and smears.

The idea behind this important advance isn't new. In fact, the principle behind the digital technique often used, called pulse-code modulation (PCM), was patented by British engineer Alec Reeves in 1939. Engineers have applied digital concepts for years to military, space, and commercial communications. But only now, with low-cost microcircuits readily available [PS, Jan.], have the same concepts become feasible for home-entertainment products.

The new techniques banish ticks and pops from discs, totally eliminate background hiss from tapes and discs, reduce wow and flutter to unmeasurably low levels, and boost the dynamic range of music—the difference between soft and loud sounds—to levels approaching that of a concert hall.

Changes in the pictures on your TV screen with digital technology are more subtle, but the new methods are already making significant changes in broadcast television.

Digital hardware

Last year, an eye-opening variety of new devices—most of them several years from market introduction—were unveiled at audio shows here and in Japan.

The new digital hardware, and the ways digital techniques can be applied to TV broadcasting, fit into several categories:

- Audio discs and players using digitally coded signals are under development by several Japanese firms. These machines work much like the Philips-MCA video discs [PS, Feb. '77] now scheduled for introduction this year.
- Tape recorders and video-cassette-recorder (VCR) adapters with digital signal encoding are also abundant in prototype form. One VCR adapter (Sony's) is already being sold. The adapters work with any of the VCR's on the market [PS, Nov. '77] and enable owners to use their decks for recording either ultrahigh-fidelity audio or TV programs.
- Hi-fi power amplifiers using a special type of digital circuit can be made much smaller than conventional amps. These so-called Class-D or switching amplifiers use power superefficiently instead of wasting energy in the form of heat.
- Digital video circuits are already being used by broadcasters

Continued

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I'm realistic. I only smoke Facts.

FACT 1: We don't want your taste buds to go to sleep.

FACT reduces the aldehyde* gases that we believe muddy the flavor of fine tobaccos so you can enjoy wide-awake taste.

FACT 2: We have smoke scrubbers in our filter.

These Purite® scrubbers work like magnets to reduce these same aldehydes and let the fine flavor come through.

FACT 3: We have a patent on flavor in low 'tar' cigarettes: #3828800.

Our Purite filter helps deliver flavor in a way so new we've been able to patent it.

Add it all up. Low gas, low 'tar,' great flavor. That's a FACT.

*Formaldehyde, Crotonaldehyde, Acrolein

Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

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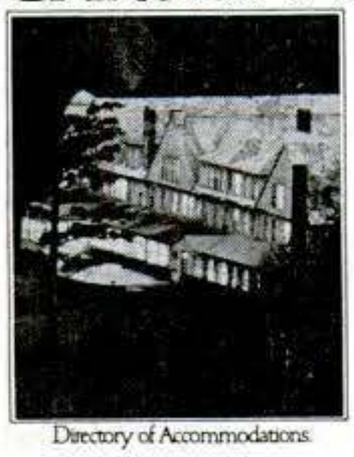
SEE NORTH CAROLINA FOR 13¢

NORTH CAROLINA



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The North Carolina Travel Package helps you plan your vacation before you get here. It's full of facts and details about where to go, what to do when you get there, and where to stay. And it's yours for the price of a stamp.

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Leather padded comfort collar. Day-long cushion comfort insole. The patented non-slip, self-cleaning, oil resistant sole is guaranteed not to wear out for one full year. Won't slip on wet wood, steel, concrete, you name it.

MAINSTREAM™

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A Natural for Every Walk of Life

in the long chain of amplifiers and switches that process signals between camera and transmitter.

• Digital TV signals broadcast to your home like a conventional VHF or UHF signal are unlikely for reasons explained later. But some day home TV receivers may pick up digital TV pictures beamed to special roof-top antennas from satellites [see "Satellite-to-you TV," page 66]. Other homes may receive extremely high-quality digital TV pictures through coaxial cable or hair-thin glass fibers [PS, August '75].

Analog limitations

The availability of low-cost circuits is one reason engineers are looking at digital technology for home entertainment. But audio experts also want to minimize or eliminate the many technical problems that plague conventional tape and disc recordings.

Most recordings start on professional analog-type tape machines, which, despite their quality and high prices, immediately limit the dynamic range of a recording. Loud high-frequency signals can easily saturate the magnetic particles on tape, causing distortion. At the other extreme, faint music signals often must be boosted in amplitude so they aren't buried in the high-frequency background hiss.

Because of these tape limitations, recording engineers and home recordists as well must restrict the dynamic range of recordings, losing much of the sonic impact and excitement of the live performance. Musical peaks are electronically and manually limited (a knob).

The problems are compounded when taped signals are transferred to plastic discs and mass produced. Fragile disc surfaces scratch easily, while dust and dirt attracted to the grooves are ground in by the stylus to cause permanent damage. Further, the restricted dynamic range from the tape may have to be compressed more. Record companies must insure that during loud passages the groove-cutting stylus doesn't create grooves that cause distortion or throw your stylus out of contact.

Most audio discs, therefore, convey a feeble imitation of the 100 dB or so difference between an orchestra's loudest and lowest-level passages. Good discs produced from

Continued

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AIR FORCE–A GREAT WAY OF LIFE

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[*Continued*]

Digital encoding of the conventional analog signals for TV pictures requires enough pulses in the digital words representing amplitude levels to recreate the image. A three-bit-long digital word, left, clearly reduces detail in flat areas. An eight-bit word, right, provides an excellent TV picture.

a master tape may achieve a 65-dB dynamic range. (For reference, each six-dB increase in sound is perceived as being twice as loud.)

The British Broadcasting Corp., obliged to provide quality stereo FM throughout Great Britain, was among the first to apply digital-signal encoding to home entertainment.

Digitized FM

During the late 1960's and early 1970's, the BBC devised a method of transmitting digitized stereo FM over the telephone lines and microwave links connecting studios and transmitters throughout Great Britain.

An analog output signal from, say, a BBC master tape is sampled thousands of times each second. Each sample, which represents the amplitude of the analog waveform at an instant in time, is coded into a series of on-off pulses called a digital code word (see box, p. 60). As the tape plays, a stream of digital words representing the music can be sent over phone lines or microwave hundreds of miles to various BBC studios.

What happens if the digitized signal is distorted along the transmission path? Signal distortions that might garble an FM analog signal have virtually no effect on a digital signal. The digital-to-analog (D/A) converter at each BBC studio need only recognize how the on-off pulses in each word are organized to recreate the exact analog signal amplitude. Digital words must almost be knocked out of the data stream before the D/A converter fails to do its job. Moreover, duplicate code words can be sent so that losing some words may have no effect at all.

After the BBC upgraded the reliability and quality of its FM transmission links, it next wanted a practical tape machine to record and play signals in a digitized form. In 1975, the BBC and 3M Company began a joint development project on a commercial digital recorder. Late last year I saw 3M's new $150,000 digital recorder at a press conference.

A demonstration tape on the professional machine had an awesome clarity and dynamic range. But the demonstration room—as with most home environments—was too noisy for us to fully appreciate the recorder's 90-dB dynamic range. The machine can record 32 separate tracks—each for separate performers, if desired—on special one-inch-wide tape.

With the techniques the BBC and 3M devised to encode audio signals, specifications such as wow and flutter, distortion, crosstalk (interference between tracks), and print-through have become inaudible or exceptionally low.

But the exciting news in the audio field is the large number of digital tape and disc machines being developed in Japan for home use. With these new machines, the superb fidelity captured by 3M's professional recorder can be transferred to mass-produced discs and tapes with absolutely no loss in sonic quality.

Most of the new digital machines are in the prototype stage and may not be available for a few years. At least nine Japanese firms have unveiled digital audio gear.

In some respects, a few of the products designed for home use are superior to 3M's costly professional tape machine. Sony's PCM disc player, for example, has a flat frequency response (not deviating more than 0.3 dB) from two Hz up to 20 kHz; 3M's tentative response specifications for the same tolerance extend from 30 Hz to 15 kHz. (The 3M machine actually covers 20 Hz to 20 kHz without significant deviation.)

Dual-mode player

The prototype disc systems from Sony, Hitachi-Nippon Columbia, and Mitsubishi-Teac-Tokyo Denka use an optical recording and playback system. Discs must be recorded at the factory. Hitachi and the firms cooperating with it are working on a two-mode disc player that can produce either video images or ultra-high-fidelity sound.

With these audio disc systems, the PCM-encoded audio becomes a spiral track of pits or bumps on the disc surface. The Philips-MCA video discs have similar tracks, but the signals are not PCM-encoded before conversion into a spiral track. As the audio disc spins at 1800 rpm, a laser beam reflected from the track is decoded into the stereo signal. To prevent problems from dropouts, about 50 percent of the digital PCM pulses are redundant. The D/A decoding circuits can sense when a dropout has occurred and use a duplicate signal.

Although PCM audio-disc players aren't available yet, in Japan Sony is selling its adapter for video-cassette recorders. This device converts a VCR into an ultra-high-fidelity audio tape recorder. The adapter (see photo) costs about twice as much as a VCR deck.

Matsushita and Mitsubishi have also shown VCR adapters. Like Sony's, these plug-in devices convert conventional analog audio signals into a PCM signal format, then into a video-type signal that the VCR can process. The encoding process is reversed during playback and the output of the adapter is plugged into a hi-fi system like any other tape machine.

Sony is also refining a different kind of digital technology that involves amplifying audio signals to drive loudspeakers. It plans to market a so-called Class-D or pulse-width-modulation (PWM) hi-fi power amplifier. An early prototype model I saw delivered 150 watts per channel, but weighed only 22 pounds and was surprising-

Continued

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OMNI'S TOPS.

Motor Trend magazine thinks so. Which is why Dodge Omni became *Motor Trend* Car of the Year.

Veteran car critics and testers have been reporting some very nice things about Omni. Like the confident feel of its front-wheel drive. And the kind of space front-wheel drive gives Omni's occupants. So, the nation s automotive press also thinks so.

We think you're going to think Omni's tops, too. Because Omni can get so much done... lots more in fact... than it did for the car experts. We say that because it will take thousands of miles around the town and out in the country to put Omni to its truest test. With you at the wheel.

$4135.* (CAR AS SHOWN)
$3706.* (BASE STICKER PRICE)

Now, car testers don't worry too much about price. But you have to. So it's nice to know Omni prices start at just $3706.* Which includes such standard items as an AM radio, vinyl body-side moldings, and whitewall radial tires. With a little judicious selection of options and trim packages, you can own an Omni like the one in the picture for just $4135.*

For that kind of money, you get a lot of versatility. First of all, Omni is built for American-sized folks. There are four wide doors for easy entry. There is a great big 10.2-cubic-foot storage compartment when the rear seat is in place. Fold the seat down, and you get a cavernous 35.8-cubic-foot area that'll take on a surprising lot of cargo. Omni is roomier than you might expect.

You can make your Omni roomier yet. More versatile. Order it with an optional factory-installed multipurpose carryall roof rack. With appropriate attachments, it'll handle bikes, skis, baggage, or other cargo up to 150 pounds. After all, the more you carry outside, the more you can carry inside.

EPA ESTIMATES:
39 MPG HIGHWAY/25 MPG CITY.

Omni is also very obliging on gas mileage. EPA estimates are 39 MPG (highway)/25 MPG (city). That's when your Omni is equipped with its standard 1.7 litre engine and four-speed transmission and 3.3 transaxle ratio. Your mileage may vary. Depends on how you drive, your car's condition, and its equipment. And California mileage is lower.

With so much waiting for you to see, and try, and feel, why not get down to your Dodge Dealer's soon. We think you'll end up buying or leasing the car so many experts say is tops in its class for 1978.

MOTOR TREND CAR OF THE YEAR

DODGE OMNI.
IT DOES IT ALL.

*Does not include taxes and destination charges.

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[*Continued*]

ly compact compared to conventional amps with similar power.

The reason for the compactness is that PWM amplifiers (see box) operate continuously at efficiencies of 90 percent or better, converting input (AC) power primarily into output power for your speakers. Most conventional hi-fi power amplifiers reach a maximum efficiency of about 75 percent only when they're supplying maximum output power (musical peaks). Ordinary amps have an average efficiency of about 20 percent, with most of the input power wasted as heat. Bulky metal heat sinks are needed to dissipate this heat.

Digital television

PCM and other digital techniques are already being used in commercial television to manipulate TV signals between cameras and transmitters. Digital techniques were used to send pictures back from Mars, and computer processing of these signals can remove noise and enhance images. Devices now on the market can convert conventional TV signals into a digital format for similar enhancement.

Also, equipment is available that digitally converts European TV signals into U.S. broadcast standards or vice versa. Other hardware insures that signals sent from one studio to another are synchronized so pictures won't roll when directors switch from one scene to another. Other digital equipment is expected to gradually replace analog video circuits and improve the quality of the picture on your TV screen.

Broadcasting digitized TV signals directly to your home could radically improve the pictures you see, virtually eliminating signal noise or "snow." But that's not likely to happen for some time because of the enormous bandwidth (range of frequencies) required for a PCM television signal (see box).

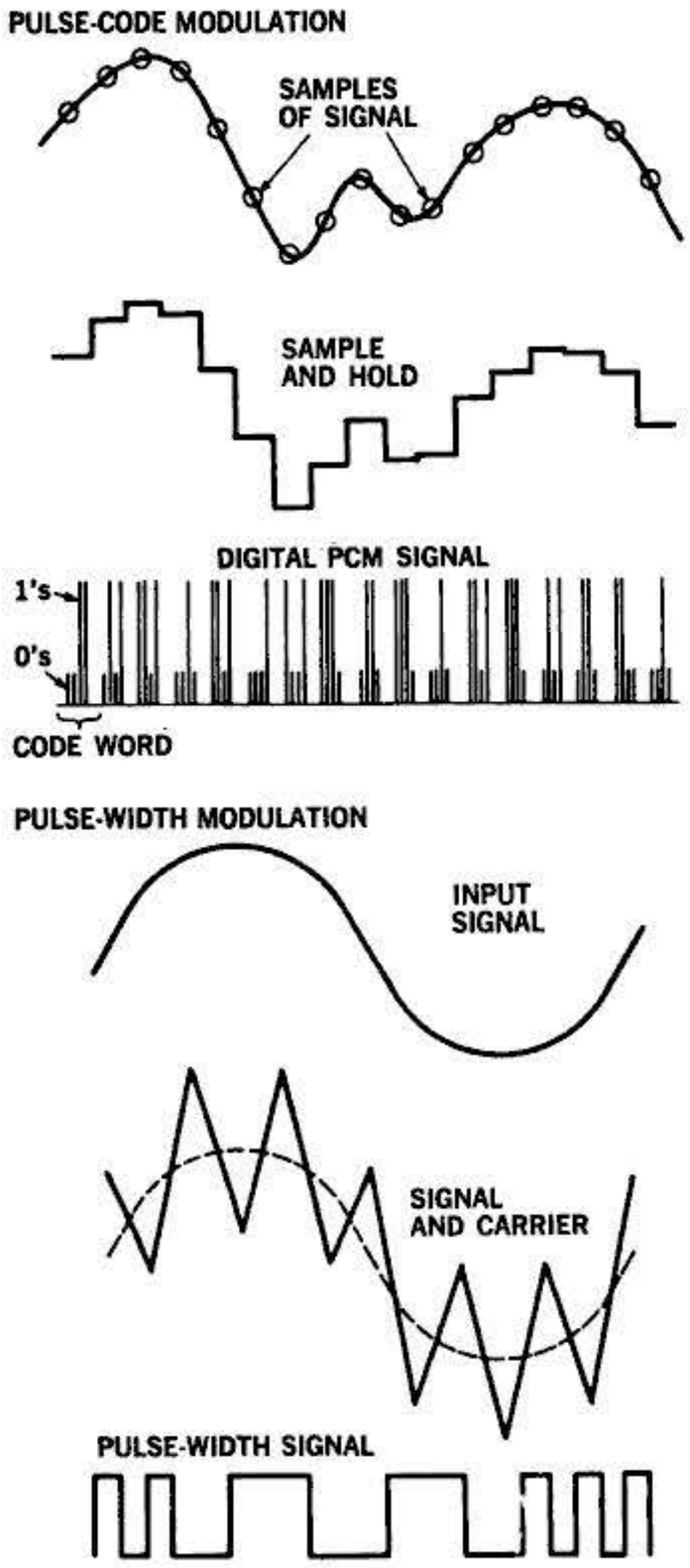
Narrowing the band

Researchers at CBS Technology Center in Stamford, Conn., and elsewhere are studying ways to shrink the large bandwidth requirements for digital TV. But for the home, methods of transmitting digital TV that can handle much larger bandwidths, such as coaxial cable or fiber optics, may be necessary.

Communication satellites, which have already been used to relay digitized TV signals, operate at extremely high carrier frequencies (thousands of megahertz). A digital TV signal, therefore, occupies a much smaller slice of the bandwidth available. Satellites may one day be used to send digital TV signals to special TV antennas in homes.

The shift to all-digital products for home entertainment will be gradual. The steep initial costs for playback hardware is likely to attract only audio perfectionists at first. But the same industry "learning curve" that enables manufacturers to continually shrink the cost of mass-produced digital calculators and wristwatches will eventually bring this dramatic advance in communications to all. PS

How analog signals are converted into digital form



An *analog* signal changes value or amplitude with time; the familiar sine wave is a good example. The voltage represented rises smoothly to a peak in a positive direction, reverses and falls and eventually reaches its maximum value in a negative direction, then returns to zero. It passes through many intermediate values in between. A *digital* signal, on the other hand, has only two states: either on or off. The signals are formed from the binary digits (called bits) one and zero. For conversion to digital form, the analog signal is sampled periodically. Viewed on an oscilloscope, the waveform (top, left) could represent a brief instant of your voice over a telephone, or the more rapid change of a high-frequency violin note from a record, or the still more rapidly changing part of a TV signal that helps create someone's eye color on the screen.

A voice signal might be 4000 Hz, the violin note 12,000 Hz, and the eye-color TV signal 3.5 MHz. For pulse-code modulation (PCM) encoding, each sampled amplitude level on the waveform is held or memorized for an instant.

Next, each sampled level in the wave form is assigned a digital code. The code is formed from the binary digits zero and one, and a code word in the digital PCM signal representing a given sample might be made up of eight bits, such as 11100011.

The ones and zeros in an eight-bit code word can be arranged 256 different ways (2^8) to represent 256 amplitude levels. A signal is usually sampled at at least twice its bandwidth frequency. A 4.5-MHz TV signal may be sampled 11 million times each second. But since each sample requires an eight-bit code word, the transmission medium for the digitized signals might have to carry at least 88 million bits per second, and more often 100 million bits per second.

That many bits each second requires a bandwidth capacity of about 50 MHz—some 10 times greater than analog TV signals.

To reproduce the conventional analog signal from the digital signal, the code words are used to recreate the original sample levels; filters then "smooth" the staircase-like steps from the waveform to duplicate the analog signal.

Pulse-width modulation (three lower diagrams at left), used in Sony's new hi-fi power amplifier also involves sampling the input signal. But unlike PCM, the samples are not coded. A 500-kHz square-wave circuit produces pulses that are converted into triangular shaped signals and mixed as signal and carrier, with the input analog signal from a preamp. This mixer stage samples the input and the resulting signal is fed to high-gain power transistors. These transistors, switched abruptly on and off, produce a series of pulses whose widths are proportional to the input signal amplitudes. A filter circuit can then transform these pulse-width signals back into an analog audio signal that's identical to conventional power-amp outputs.

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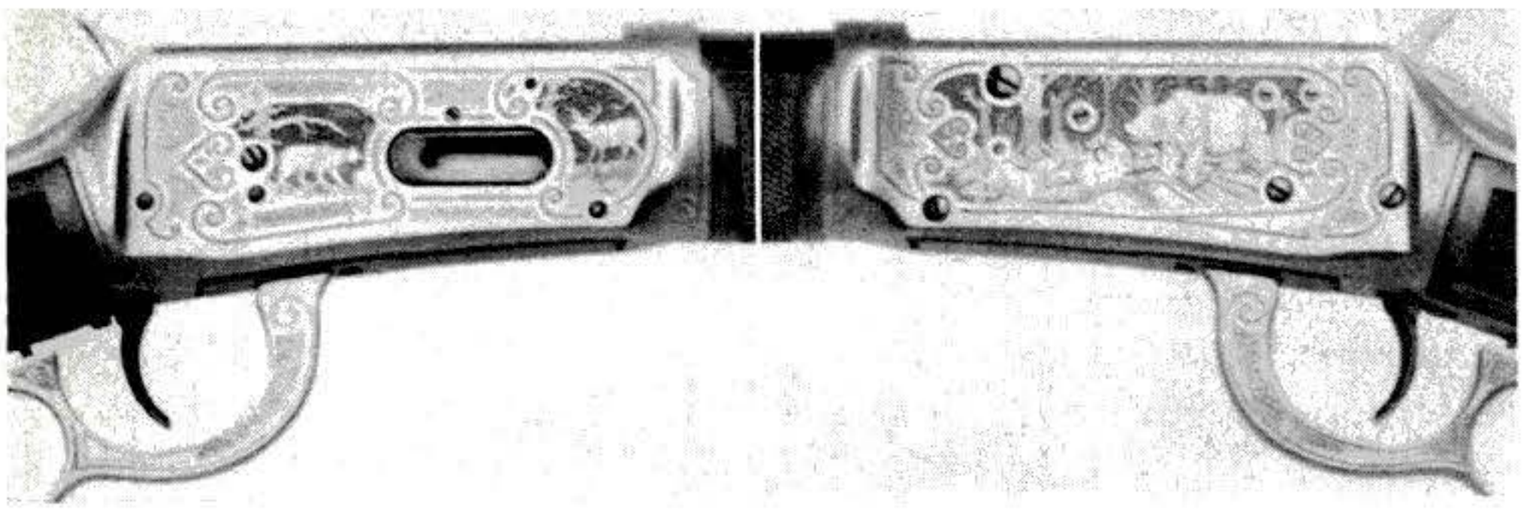
ON TARGET

By PAUL WAHL



Five-millionth Winchester 94

"We believe that no repeating rifle system ever made will appeal to the eye and understanding of the rifleman as this will, and that use will continue to warrant first impressions." That's what Winchester said when it introduced the Model 1894 lever action in its catalog of 83 years ago. And the company was right. Virtually unchanged, the rifle has been manufactured continuously ever since and is by far the all-time best-seller in the firearms field.

Fifty years ago, Model 94 was the first sporting rifle in history to pass the one-million mark in production.

This year, the five-millionth Model 94 will be turned out. To celebrate this achievement, Winchester has made just 1500 of the limited-edition Model 94 Carbine, an instant collector's item sure to appreciate rapidly.

William F. Steck, Winchester's vice president for marketing, says, "We felt that nothing short of a spectacular firearm, issued in very small numbers, would properly serve to honor the most popular sporting firearm in American history." This special 30-30 carbine certainly is "spectacular."

In satin gold-plated finish, the receiver bears faithful replicas, etched in triple relief, of turn-of-the-century Winchester Style No. 1 engravings by the master artist, John Ulrich. On the right side there is a mule deer faced by a crouching mountain lion; on the left, a pair of hounds holding a grizzly at bay. And both sides are further embellished with intricate scrollwork, which also decorates the hammer and lever. These parts, as well as the upper and lower tangs, are satin gold plated to match the receiver. Other metal parts have a highly polished blued finish. The classic carbine-style stock and forearm are of fancy figured American walnut with deep-cut hand checkering and a high-gloss finish.

Each of these guns comes in a fitted wooden presentation case and is accompanied by a book on the history of the Model 94 and the famous Ulrich engravings, and a certificate of authentication signed by the president of Winchester. While the suggested retail price was $1500, these carbines already command a premium.

There's another attractive new special-edition Model 94, the Legendary Lawmen commemorative, recently issued to honor frontier peace officers. This is a deluxe 30-30 carbine with the 16-inch barrel of the rare early Trapper's Model. Its antique silver-finished receiver is decoratively engraved on both sides: on the right, a lawman galloping his horse and on the left, bringing a captive outlaw into town. The traditionally styled stock and forearm of semi-fancy American walnut are finely checkered and satin finished. A nickel-silver medallion is embedded in the buttstock. Twenty thousand of these carbines have been put on sale at $375 each. From Winchester-Western Division, Olin Corp., New Haven, Conn. 06504.

Convert to 410

A 410-gauge shotgun is nice to have around for small-game hunting and pest control or for more challenging clay-target shooting. But you might hesitate, at today's prices, to put another gun in your rack. With the Four-Tenner by Savage Arms (Westfield, Mass. 01085), you can add 410-gauge capability to your present 12- or 20-gauge break-frame single- or double-barrel shotgun at modest cost.

This gauge adapter is a barrel insert that takes 2½- or three-inch 410-gauge shells. A foot long and weighing a mere five ounces, it simply chambers like an extra-long shell and is centered in the barrel by a neoprene O-ring for accurate patterns. Its auxiliary extractor is aligned with that of the gun for normal shell extraction. The Four-Tenner works just fine.

For $16.95 per tube, you can put one of these adapters in each barrel of your favorite side-by-side or over-and-under double. That's a lot less than the price of the cheapest 410 single-shot.

New books

This month I have several great new books to tell you about. And I truly enjoyed each of them. Especially fascinating to me were two encyclopedic volumes providing information on the latest military weapons. The first is the 11th edition of the late W. H. B. Smith's 33-year-old classic, *Small Arms of the World*, revised by Edward Clinton Ezell, with 671 pages and over 2000 illustrations ($20 from Stackpole Books, Box 1831, Harrisburg, Pa. 17105). Covering similar territory in a more concise and accessible fashion is *Military Small Arms of the 20th Century*, co-authored by the British authorities, Ian V. Hogg and John Weeks; it has 284 pages and more than 600 illustrations ($19.95 from Hippocrene Books, Inc., 171 Madison Ave., New York, N.Y. 10016). If you're interested in military hardware, you should get both of these books.

For the avid shotgunner, there's L. R. Wallack's *American Shotgun Design and Performance*. It's *the* up-to-date, comprehensive work on the subject; 184 pages, illustrated, $13.95. For riflemen there's the excellent companion volume, *American Rifle Design and Performance:* 213 pages, illustrated, $12.95. Both from Winchester Press, 205 E. 42nd St., New York, N.Y. 10017.

The Great Outdoors Catalog, by Kenn and Pat Oberrecht, is a must for every outdoorsman. It tells where and how to shop by mail for all kinds of hunting, fishing, camping, and other outdoor gear; 256 pages, illustrated ($7.95 paper, $12.95 cloth, also from Winchester Press). PS

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Popular Science

PS | What's News

"I want to make a prediction. Not every one in this room will have a computer of his own in three years. Some of you will have two."

The scene was the elegant Oval Room of Boston's Copley Plaza Hotel. The event: a briefing session held by Worcester Polytechnic Institute for business executives on the effect the microprocessor revolution would have on business and industry. The speaker was Alan R. Kaplan, director of programming for DataComm Interface, a computer company.

I was there because I and the other editors of *Popular Science* are becoming more convinced every day that the microprocessor, used in personal computers and in scores of other applications, is going to have an enormous impact on all of our lives.

I wanted to learn more about what the microprocessor and computer companies think the future might hold.

What the pros think

There was a curious divergence of opinion. Some of the manufacturers and designers of microprocessors were so close to the problems that they were unable, in my opinion, to see the big picture unfolding before them. They were concerned with yield rates, for example—how many good microcircuits and how many bad ones you get in a production run. They were concerned about whether the general public will ever really get interested in home computers. "How many people that you know are going to want to learn BASIC?" asked one executive. He was referring to the programming language through which most home computer users talk to their machines.

That was, in my opinion, sort of like asking at the beginning of the automobile age how many people would ever want to use such a device. It was obvious that many women and some men wouldn't even be able to turn the crank. And besides, the noise scares horses.

It's true that at the moment you'll have to learn BASIC (or some more advanced language) to talk to a computer. But that will soon be a thing of the past for most of the tasks most people will want to use them for. Trial programs have already been demonstrated in which the computer asks you what you want to do. You indicate one of the offered choices, and the computer then leads you through the entire process, asking questions to which you respond. There's no doubt that programs for doing your income tax, for having the computer regulate a series of daily events in your home, and for many other functions will soon be available in such a form that they can be operated by anyone who can read and write. Computers—even the home variety—are becoming so powerful that they can now be designed to talk your language; you don't have to learn theirs. (Bill Hawkins described an auxiliary circuit board that both listens to and understands your spoken commands and another that synthesizes a human voice in his piece, "Plug-in Circuits," in PS, Nov. '77.) Thus the day is not far off when you won't even have to type; you'll chat with your computer.

Computers for everyone

To me, the speaker who seemed to have the clearest vision of what the microprocessor and cheap computer revolution was all about was Alan Kaplan, whose prediction was reported at the beginning of this column. He strongly urged the executives at the meeting to learn enough about the subject to know what is going on. "If you want to understand computers, go get one," he said. "They're cheap enough. Learn BASIC. It's very easy to do."

He emphasized a point we've made repeatedly in *Popular Science*. "Systems that can now be purchased for about $700 are in *every* way equivalent to the systems that Digital Equipment Corporation was selling for $10,000 four years ago. They're not only in every way equivalent—please quote me—they are superior. And they're superior to systems that were selling for hundreds of thousands of dollars just a few years before that.

"Personal computers are not toys. There is not a single application in any laboratory, in any business, in any scientific or commercial equipment, pursued at any cost with any configuration of hardware or software that does not have its parallel at the personal computer level."

What does the future hold? "At one time," Kaplan continued, "the privileged man was the literate man. Every town had a scribe so that people could communicate from one town to another. The literate man of the 20th century will be someone who understands programming. You will be illiterate if you cannot do some form of programming in the next few years.

"The computer is a tool. It's a mind expander. It's as basic as the wheel and the lever. In the industrial revolution we learned to use machines. The machine expands our muscles. But we are not creatures of muscle; we are creatures of mind. What the computer does is to expand your mind.

"Twenty years from now, historians will look back at this time and see something they will label the intellectual revolution. It will make the industrial revolution look pale by comparison."

I believe these bold predictions. When the automobile came along, we thought it would just get us around a little more efficiently than the horse. It did that, but it also changed the way we work, play, and build cities. It changed our lives in fundamental ways we could not predict at the time.

I think the same thing will happen with the personal computer. Today, we think of it in terms of taking over jobs we now do by hand. Sure, it will balance our checkbooks, do our income tax, play checkers or chess, keep recipes filed, look up telephone numbers, and perform hundreds of other chores we now do in a more laborious way. But the real impact, I believe, will be in ways we can't even guess now. When everyone has what amounts to unlimited computing power, human ingenuity will find hundreds, thousands, millions of ways to use it. I bet the changes brought about by the intellectual revolution *will* make the industrial revolution look pale.

Executive Editor

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Satellite-to-you TV

is only one of the new comsat wonders

TDRS—1980, WESTERN UNION

How direct signals from the sky can enrich your TV fare and improve communications

By SUSAN RENNER-SMITH

With a roar, the Conemaugh River flattened a 30-foot flood wall, then raged through the streets of Johnstown, Pa., last July. For the third time in a century numbed survivors began shoveling away the muck. But one thing was different this time. Though phone service was chaotic as expected, rescue workers had a link to the outside world—via satellite.

A four-foot dish antenna let Red

Advances in satellite technology

Remember Early Bird? It relayed 240 phone calls or one TV broadcast—a great achievement in 1965. Since then, communications satellites (comsats) have grown both in number and capacity. Today, there are about 30 comsats in orbit, and more are planned.

The U.S. comsats shown illustrate the technological advances of the past few years. **Westar** (like most comsats) hovers in a geostationary orbit, 22,300 miles above the equator. There, the satellite's orbital velocity matches the earth's rate of rotation, so it seems to hang stationary in the sky. Like Early Bird, Westar is a "spinner." Hydrazine-fueled thrusters keep it rotating about its axis to stabilize it in orbit, so its "despun" antenna stays fixed on target. Solar cells on the drum-like body provide 262 watts for the Hughes-built bird. Westar can handle 7200 phone calls or 12 TV broadcasts. This traffic is relayed by 12 transponders that amplify the 6 gigahertz "uplink" carrier frequency from earth and retransmit it as a 4 GHz "downlink." Most signals are handled conventionally, with each message on the carrier assigned to a separate frequency. But use of new, ground-based digital transmission equipment [see "Digital Hi-Fi and TV," p. 50] will expand Westar's capacity. With signals converted to a digital form, pulses from each message can be sent in short bursts, leaving room to sandwich in pulses from other messages. Thus more than one signal can be sent simultaneously on a single frequency.

The first body-stabilized comsat, the experimental **ATS-6** built by Fairchild is kept oriented by a set of internal momentum wheels (flywheels). Based on information from onboard sensors, a computer directs the wheels to spin as necessary to adjust the spacecraft's attitude. Unlike spinners, which expose only about 40 percent of their solar cells

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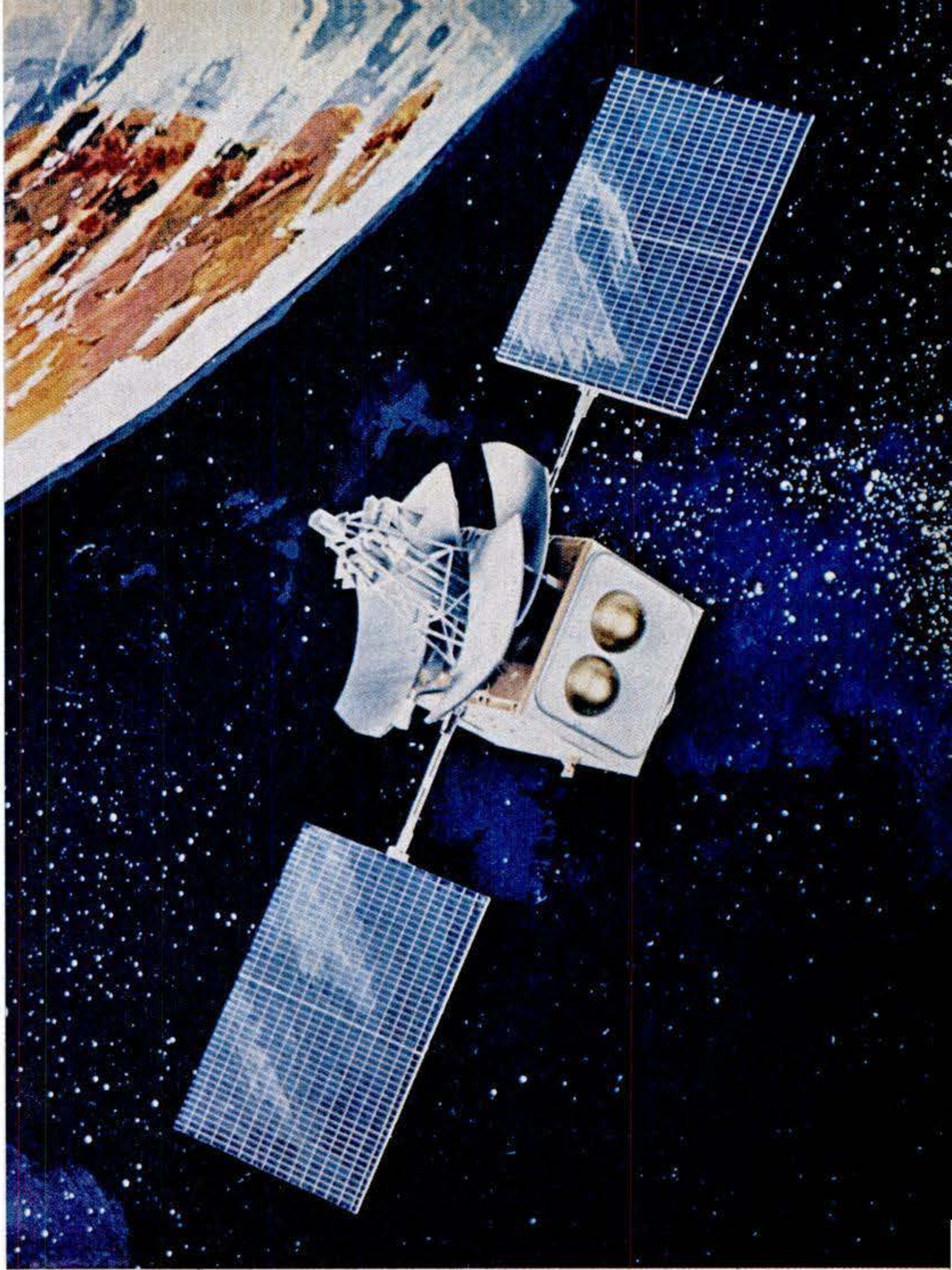
WESTAR—1974, WESTERN UNION

ATS-6—1974, NASA



SATCOM—1976, RCA

Cross workers beam messages 22,-300 miles up to an invisible ear in the sky—the experimental Communications Technology Satellite. CTS, jointly funded by NASA and Canada, is today's most powerful comsat; it has a huge solar array that generates 1000 watts. The satellite picked up the faint signals from Johnstown's small dish, amplified them, and bounced them down to an earth station outside the disaster area, where they were patched into regular phone lines.

Not only did the Red Cross request supplies (including 5000 shovels) via CTS, but Johnstown

Continued

to the sun at a time, ATS-6 has a fixed solar array. Two curved panels on extended booms face east and west, so that at least one is always in sunlight. The 500-watt array, coupled with a huge (30 ft. in diameter) dish antenna, allows the comsat to transmit directly to smaller earth stations.

Satcom, today's only commercial, body-stabilized comsat, has a clock-controlled drive that keeps its two solar paddles facing the sun. The 75-sq.-ft. solar array generates 740 watts. Messages sent via this RCA-built comsat are polarized both vertically and horizontally (the wavefronts travel at right angles to each other). Satcom's curved antenna reflectors have overlapping grids to relay these polarized signals. With this system, two signals can be sent simultaneously on the same frequency, so that Satcom's 12 transponders handle 24 channels—double Westar's capacity.

The advanced **TDRS** (Tracking and Data Relay Satellite) will be one of the first comsats to be launched by Space Shuttle. It'll also be the largest of the modern comsats—57.2 ft. from tip to tip of its solar panels. These will generate 1700 watts for the TRW-built, body-stabilized satellite. Another first: TDRS can operate in three frequency bands reserved for commercial use and satellite tracking: the C-K-, and S-bands. Today's comsats share the C-band (6/4 GHz) with earth-based microwave communications, so most ground stations are located in interference-free areas. By contrast, the high-frequency K-band (14/12 GHz) is less congested, so earth stations can be placed closer to users. This super-high-frequency band also has more message-carrying capacity. The third, lower frequency, S-band (2.3/2.2 GHz) will be used by NASA for tracking and relaying data from the Shuttle to earth (see text). To handle transmissions on these multiple frequencies, TDRS has a complex assortment of six antennas. A 30-element phased array at its hub can track 32 spacecraft simultaneously.

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residents also used the satellite link to telephone relatives outside.

Only a few years ago, it would have taken weeks to install the huge antennas, transmitters, and other equipment needed for such a satellite hookup. But with the new generation of powerful comsats (see box p. 66) satellite communications are more flexible. Besides emergency applications, the startling possibilities include direct home reception of satellite TV transmissions. And today's technology also makes it possible to use the earlier generation of comsats in new ways.

The technology is developing so rapidly that, had the Conemaugh River rampaged just a few months later, rescuers could have talked via comsat without a four-foot antenna.

"We now have the capability to provide two-way voice communication between terminals that fit in an ordinary briefcase," Sam Hubbard, NASA's Deputy Director of Communications, told me in his matter-of-fact way. But there was a hint of pride, even awe, in his quiet voice as he sifted through a stack of documents. Producing a photo of the new device (facing page, right), he explained: "Two-way means we can put one of these briefcase terminals anywhere within sight of a satellite and it can talk to any other terminal that's also in sight of the satellite."

Since all of the continental U.S. is "in sight" of ATS-6, this means rescue workers could communicate over distances far greater than those reached by conventional two-way radio. And, since satellite messages are beamed directly to and from the sky, they are not subject to interference from obstacles such as hills or buildings.

"We hope to conduct a number of public-safety type experiments," Jerry Freibaum, manager of NASA's Technical Consultation Services, told me. "Emergency-services people could use the briefcase during natural disasters—tornadoes, floods—when all electricity fails. Set-up time for this unit is less than one minute so they could get messages out very quickly."

In the future, rescue workers won't even have to lug briefcases around. Back in November, I saw an impressively small, walkie-talkie-sized earth terminal capable of two-way voice communications via satellite. And now they've got a pocket-sized, receive-only unit.

TV direct from the sky

Even more dramatic than these miniature terminals are the small TV antenna and converter shown on the facing page. With them, an ordinary home receiver can pick up TV signals broadcast via CTS.

This is new? Haven't we had TV programs via satellite since 1964, when we saw the Olympics direct from Japan? It *is* a breakthrough when you consider how we currently get "live via satellite" broadcasts on our home screens. From the point of origin, TV signals are carried by land links (cables or microwave towers) to an earth station some distance away. There, a powerful, 100-foot antenna beams the signals up to a satellite, which relays them down to the other huge antennas trained on it. From these earth stations, the signals again travel through land links to participating TV stations—which rebroadcast the program over their own transmitters.

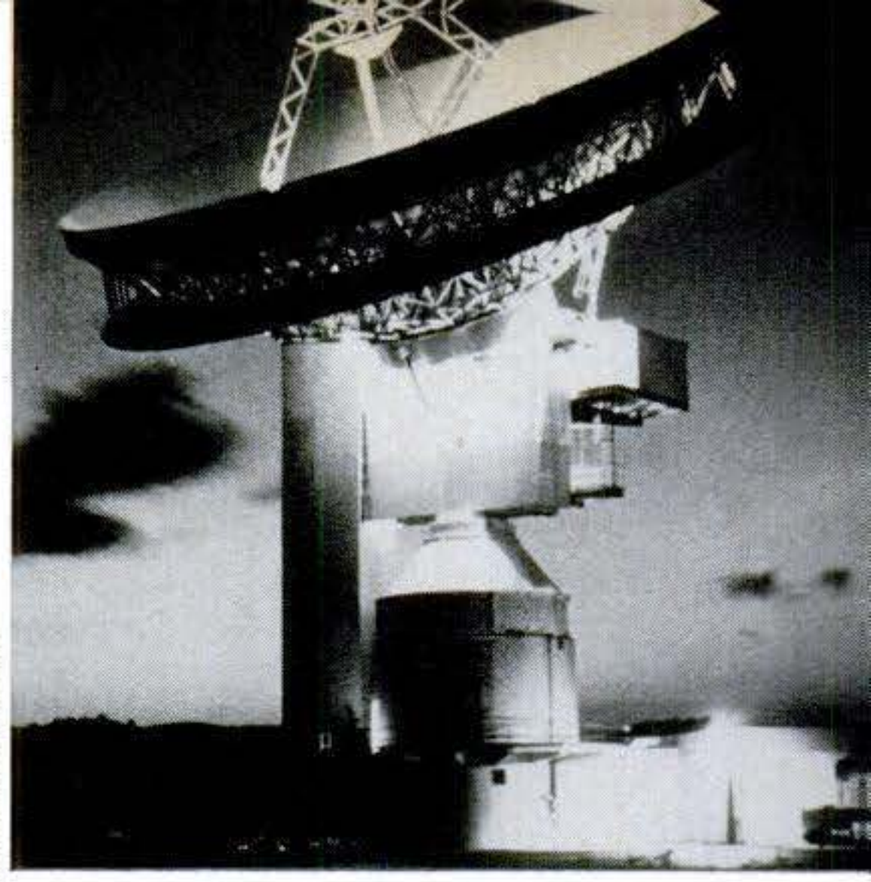
By contrast, the strong signals from CTS, transmitted at super-high frequencies, can home in directly on the mini-antenna.

"The FCC tested this terminal to see how it worked under conditions of very high interference," Sam Hubbard told me. "They took it all over Washington; they set it up near the runway at National Airport; they even set it up under a railroad platform. In all cases, they were amazed at how little signal was lost."

> "We might choose from a smorgasbord of TV programs broadcast directly at us"

With such a system, our TV diet could be much richer. We might choose from a smorgasbord of TV programs broadcast directly to us—via satellite—from all parts of the country. But commercial considerations and federal regulations make direct satellite TV unlikely in the near future—at least for U.S. viewers. (Canada and Japan are planning experiments with the system.) The new comsat technology, however, *is* affecting our lives today, in less dramatic ways.

In fact, if you should have a heart attack in southern Mississippi, you'll find comsat technology quite dramatic. There, all cardiac cases and serious accident victims from a seven-county area are rushed to one hospital—Forrest General in Hattiesburg. Because of the distances involved, the mortality rate is quite high. Now, one of the ambulances is testing a small, roof-mounted antenna that works with ATS-3, an older NASA satellite.



ALLAN GALFUND

Sending to the sky, the giant (97-ft. diameter) antenna at Cayey, Puerto Rico, relays messages overseas via Intelsat. Most earth stations are this size.

Sam Hubbard spoke with deep satisfaction as he described this life-saving program. "While the ambulance speeds along, the attendants can transmit medical telemetry to the emergency room," he said. "And, through a two-way voice link, they can talk to the hospital staff."

If you check into a Veterans Administration hospital, you may also benefit from satellite technology. Via a satellite TV hookup, the staffs of 170 VA hospitals will receive regular briefings from medical specialists. And instead of just watching a televised lecture, these doctors and nurses could become active participants. A two-way video hookup would let them question the "visiting expert" and even present patients for examination. Other government agencies have already used CTS for video-conferences—NASA does it regularly.

"When we want to meet with NASA personnel in Maryland, Ohio, or California, instead of traveling, we can just walk down the hall to our teleconferencing room," said Jerry Freibaum. "From there, we can see and talk with three NASA centers at a time."

Commercial comsat advances

Use of comsats for business conferences is not limited to the government. Last October, for example, 2000 employees of Lanier Business Products attended their national sales meeting in Atlanta—without traveling there. A three-hour demonstration of the new product line was beamed, via Westar, to 12 Lanier offices across the nation. Though this was not a two-way

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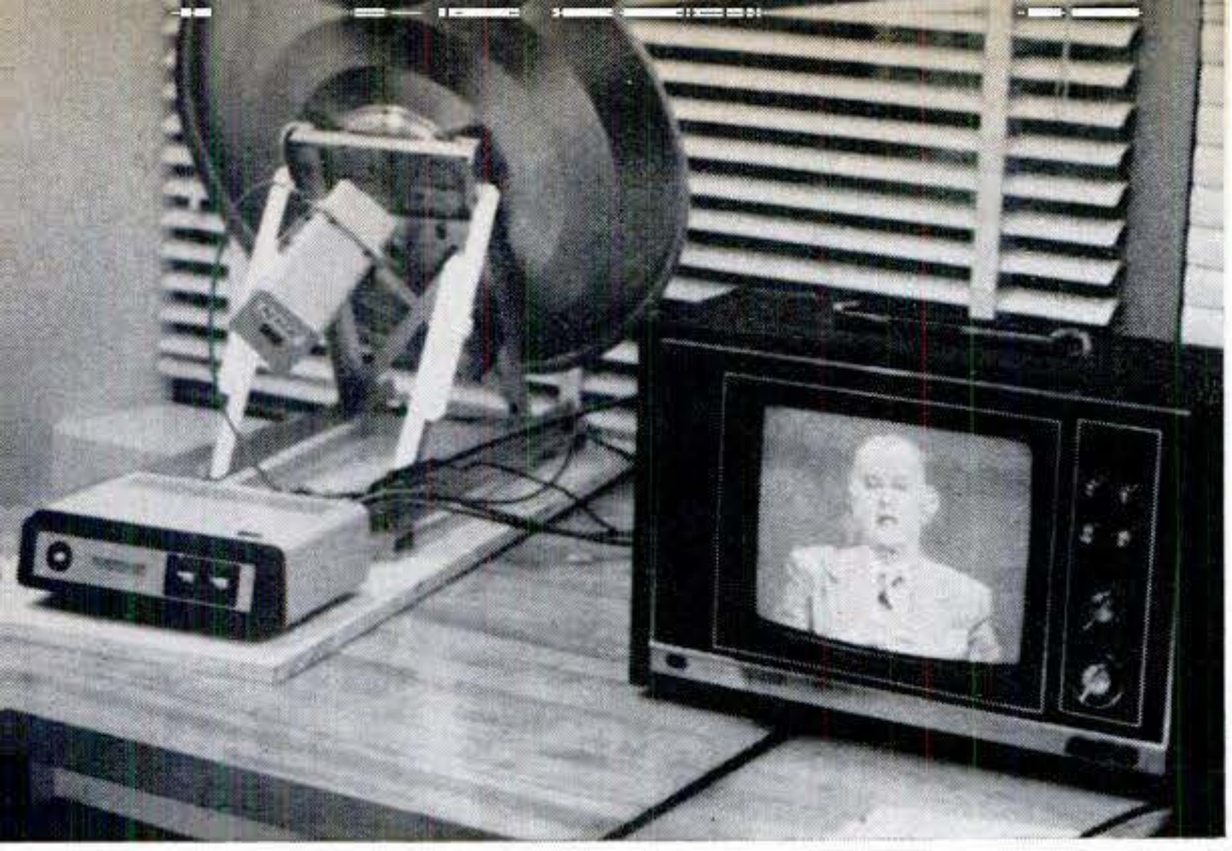
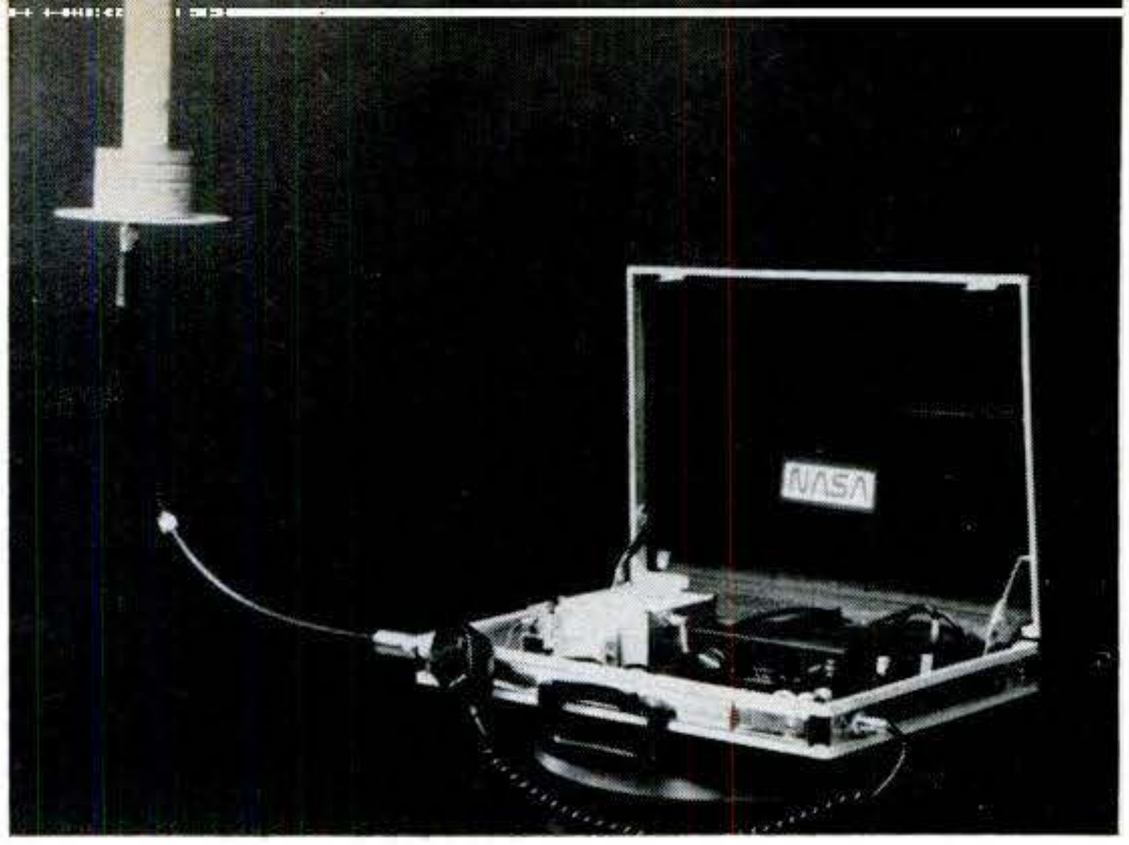


CANADIAN TELECOMMUNICATIONS COMMISSION

Peering through the blinds, this tiny (two-ft. diameter) antenna picks up super-high-frequency TV signals transmitted via the powerful CTS experimental comsat. The frequency-converter box at front feeds the signals to an ordinary TV set.



Shrunk to the size of an attache case, this miniature earth station can both send and receive voice messages via satellite. The briefcase holds a converted two-way radio and a battery pack. The antenna? A sawed-off can and a wire-wrapped tube.

video conference, it is an example of how the older generation of comsats, like Westar, are being used in exciting new ways.

In fact, though direct home TV via satellite may be commercially impractical, today's comsats are expanding our choices of TV viewing.

- Weary travelers can settle down before their hotel-room TV set and watch, via Satcom, a first-run movie on Home Box Office, or a nightclub revue on Showtime.
- Cable-TV subscribers can bypass the networks and tune in a "superstation"—a local station that's gone national via comsat. The first, Atlanta's WTCG (owned by Ted Turner, the zany America's Cup skipper) now sends Atlanta Braves games live, via Satcom, to almost a million cable subscribers across the U.S.
- Your local public TV station will have more to offer by 1979. That's when PBS will start transmitting four channels worth of programs via Westar—as compared to the one channel its present land-based network can handle.

Though more and more TV shows are sent via outer space, television transmission is actually a small part of most comsats' workload. Commercial communications satellites function mainly as giant switchboards in the sky, relaying hundreds of thousands of phone calls daily.

Of course, most of us know that overseas phone calls can be beamed by satellite. But did you know that when you call long distance to "share a smile" your smile may make a 45,000-mile round trip up to the sky and back? Since 1976, AT&T has routed part of its long-lines traffic through two Comstars leased from Comsat General. These Hughes-built birds are an advanced type of spinner—each can handle 18,000 phone calls simultaneously.

Communications of the future

Comsats can also relay data from computers, teletypes, and facsimile copiers. Though data communications may seem more specialized than other comsat uses, this fast-growing field may soon subtly affect both our business and private lives.

Already, if you live in Florida, you can pick up today's copy of the *Wall Street Journal*—hot off the satellite. The paper is transmitted, page by page, from the *Journal's* own earth station at a Massachusetts typesetting plant, via Westar, to a printing plant in Orlando.

The news services, AP and UPI, are also planning satellite distribution. One reason: It's cheaper, if the distances are great enough. A hop up and back costs the same whether the data is being sent 100 or 3000 miles. And the combination of improved techniques and advanced comsats will make data transmission more efficient.

Computers already talk to each other over satellite-linked phone lines, but soon they'll be talking directly via 15-foot antennas that can sit on an office rooftop or in a factory parking lot.

Later this year, such antennas will link computers at three Boeing Computer Services facilities and at two Sperry Univac research centers. American Satellite Co. (a subsidiary of Fairchild Industries that rents transponders on Westar) will set up these comsat/computer links. "We're doing today what others are saying they'll do in the 1980's," commented Fairchild's Maston Jacks. "We've made major breakthroughs in digital transmission."

Digital transmission is both faster and more efficient. "It takes seven hours to transmit a reel of computer tape at the current generally available rate of 9600 bits per second," said P.N. Whittaker, president of Satellite Business Systems (SBS). "At digital transmission speeds of up to 1.5 megabits per second, it will take only three minutes."

In 1980, SBS plans to launch a powerful, all-digital satellite that will operate on the higher, uncongested K-band frequency. Transmitting via a network of rooftop antennas, the SBS satellite will make possible a complex "total communications package" for businesses—including high-speed data transmission and two-way video-conferencing. SBS is now using the powerful CTS satellite in a series of tests of these projected services.

In 1980, AT&T and GTE may also offer satellite business communications services via Comstar. And, by 1980, Western Union will have TDRS.

Perhaps the most amazing satellite yet, TDRS will be the first double-duty comsat. Western Union will use it to replace the aging Westars and to set up an advanced communications network. And NASA will use it to track and relay data from low-orbiting satellites and the Shuttle. TDRS will "see" these spacecraft during 80 to 100 percent of their orbits—as compared to present earth stations which can track each satellite for only 15 percent of its orbit.

As comsats quietly revolutionize business and government communications, some of the advances might filter down to the average consumer. We may have little dish antennas on our TV sets sooner than we think. PS

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New comfort and convenience on the trail: '78 camping gear

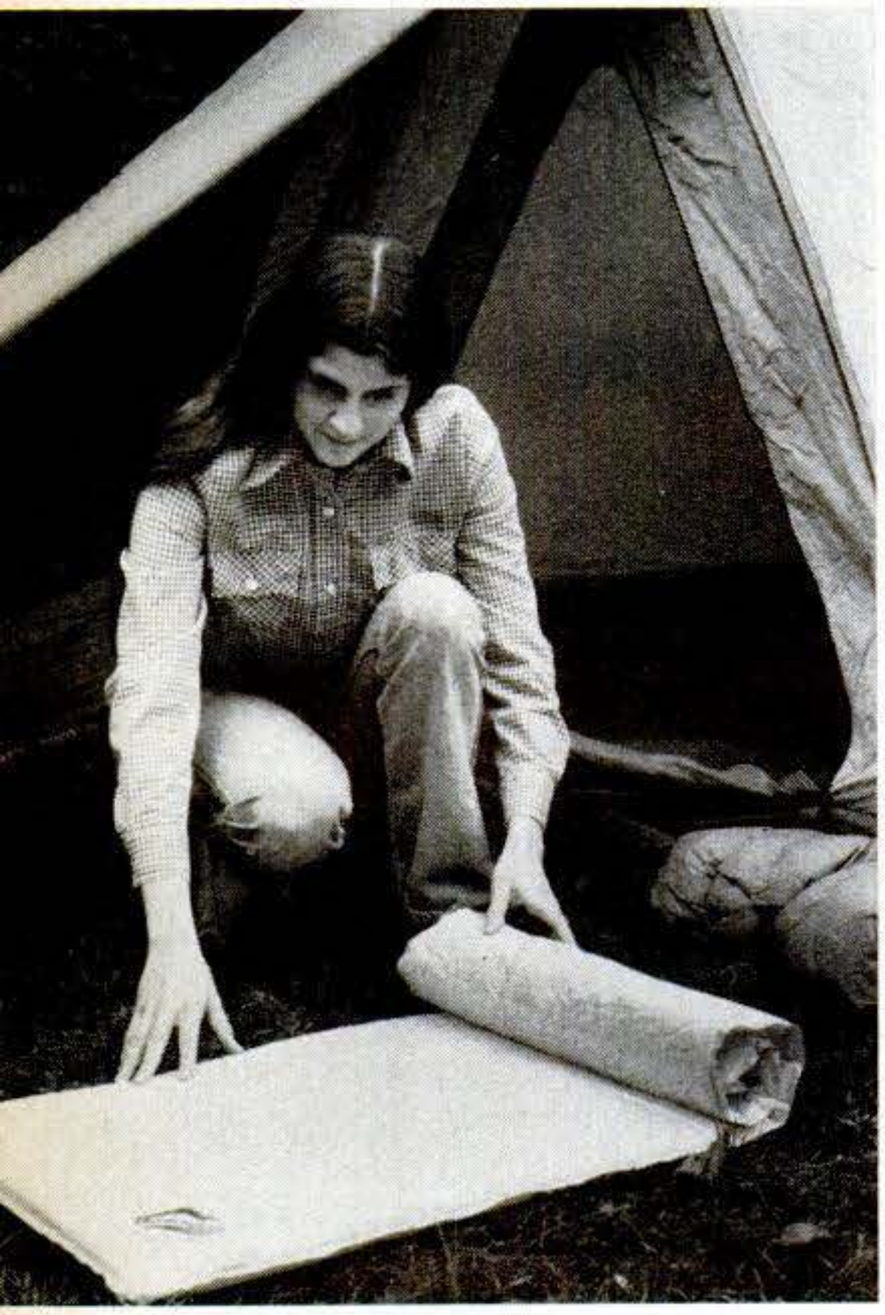
By V. ELAINE SMAY

Technology often gets blamed for destroying the wilderness. But how many of us would be able to enjoy the wilderness without it? Strong, lightweight materials and ingeniously designed gear, all a product of modern technology, have opened up the woods—especially to those of us who can't afford two porters and a guide. And the improvements continue. This year our search for new camping gear has turned up some especially interesting items. Among them:

- Self-igniting lanterns small enough for backpacking.
- A stove that can use many different liquid fuels.
- A solar-powered water heater compact enough for car or RV.

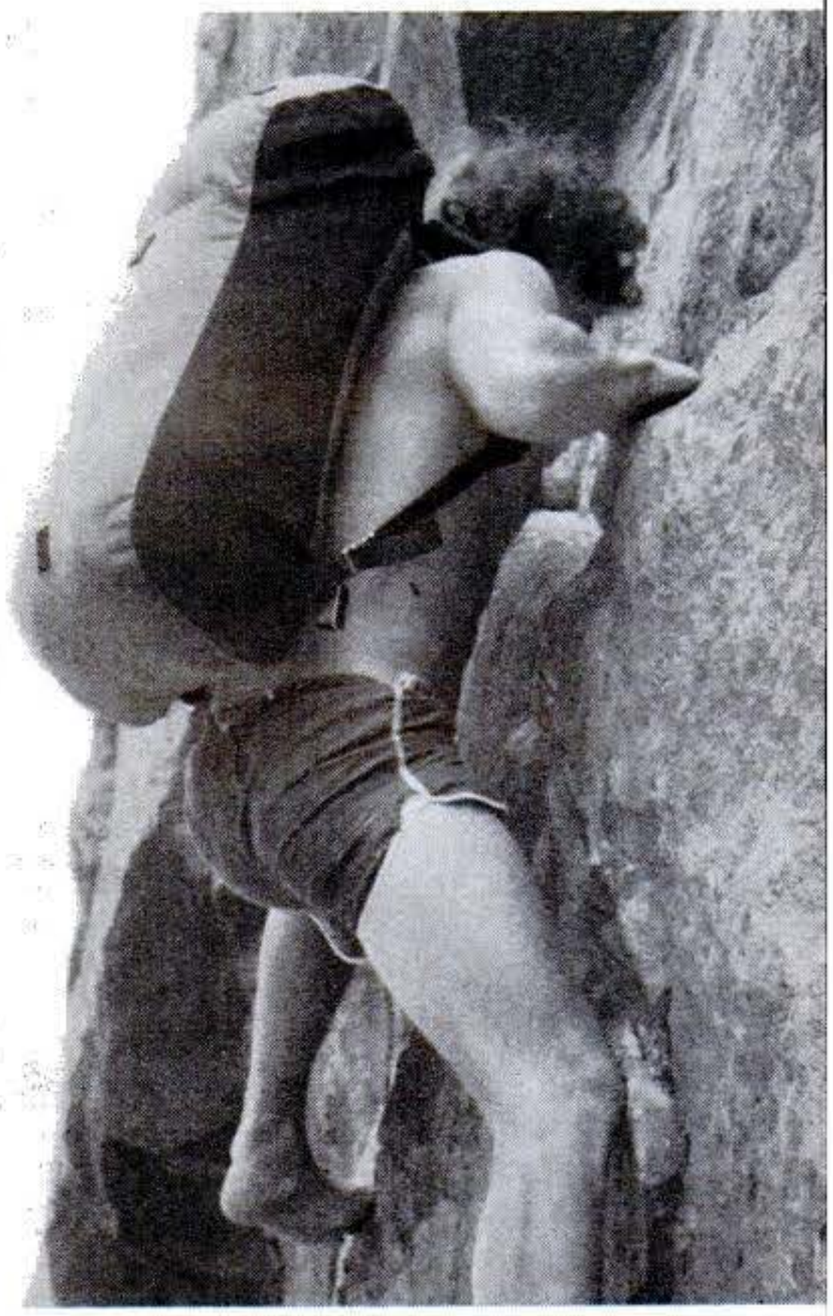
But perhaps the most significant development is a new fabric that really is waterproof *and* breathable.

Flyless tent is made of waterproof *and* breathable Gore-Tex fabric. Roomy (80-in. long) two-person tent from Early Winters Ltd. is rugged enough to eliminate ground cloth, too. Three-season Light Dimension (shown) weighs 3½ lb., costs $195. Four-season Winterlight (4½ lb.) is $245.



Self-inflating air mattress has airtight, waterproof cover, insulating core of open-cell foam. Just open valve and mattress unrolls as it self-inflates. Add a couple of breaths for firmer support. To deflate, open valve and roll tight from opposite end. Three-quarter size (19-by-47-by-1½-in.) Therm-a-Rest weighs 24 oz. $30.50 from Cascade Designs.

Rainwear of Gore-Tex really keeps you dry, since water doesn't *get* in and water vapor doesn't *stay* in. Parka and anorak from Early Winters have underarm two-way zippers for ventilation, Velcro closures on cuffs and pockets, powder shirts to keep out wind and snow, adjustable hoods. Parka is $79.95, anorak $62.95.



New soft pack from Lowe Alpine has no straight lines, fits snugly against back, comes with removable waist belt. Pack is larger at bottom so bulk of weight can be where it won't cause shift in balance. Top is slanted back so climber can look up easily. Contour I holds 2600 cu. in., costs $48.50; Contour II holds 1500 cu. in., costs $29.50.

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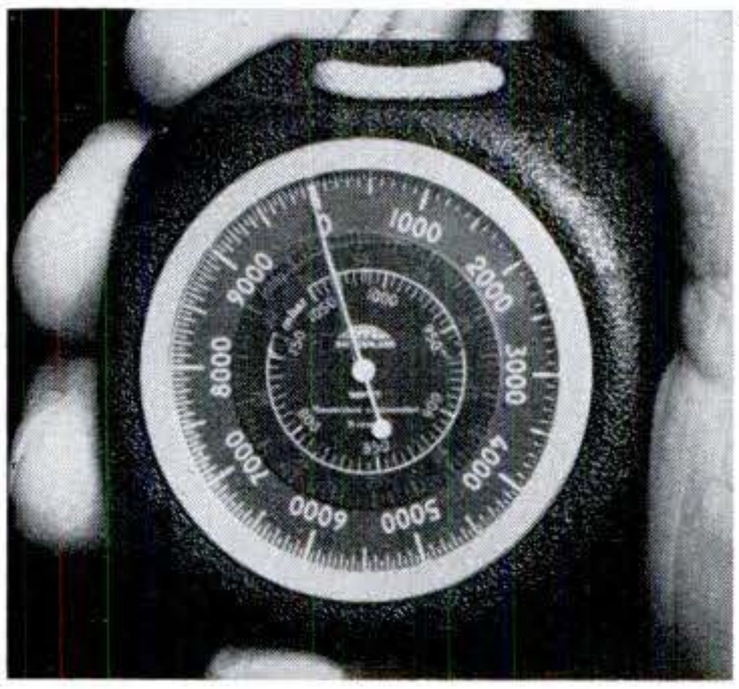
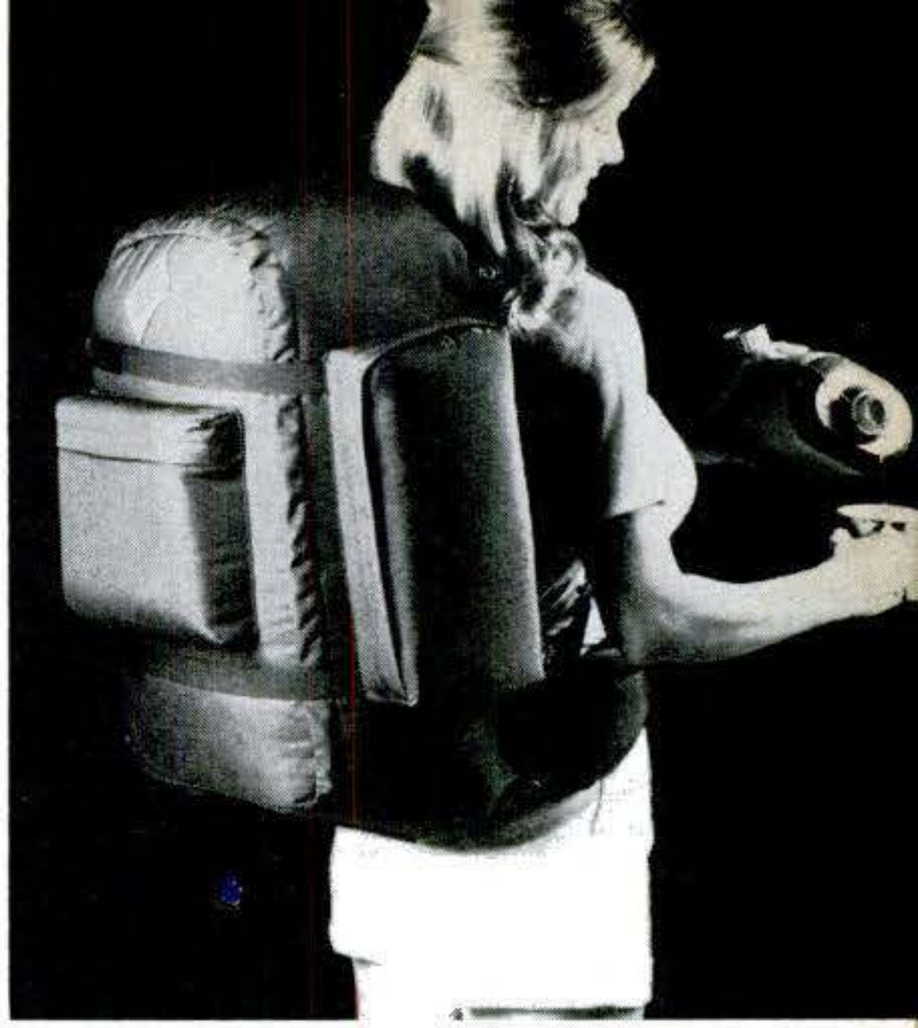
Gore-Tex, made by W.L. Gore and Assoc., is a microporous film of expanded polytetrafluoroethylene (PTFE) resin (Teflon is Du Pont's trade name for PTFE). To make the film, this plastic resin is pulled rapidly and billions of tiny pores open. A square inch of Gore-Tex contains more than nine billion pores. A droplet of water is 20,000 times larger than one of the pores and will only pass through under 60 psi pressure. (The Army calls anything waterproof that resists penetration at 25 psi or above.) But a molecule of water vapor is 700 times smaller than a Gore-Tex pore, so it passes through readily.

Gore-Tex film must be sandwiched between two other fabrics for strength. Most manufacturers use nylon, polyester, or taffeta to face and back it. Gore-Tex laminates are being used in tents, rain gear, and as covering for down bags and clothing. The stuff is expensive, but it really works. I know. I've been wearing a Gore-Tex parka like the one shown on the facing page for a couple of months now. I even wear it for my morning runs on rainy days.

You'll find a Gore-Tex tent as well as the parkas on these pages —along with a varied collection of other gear that should make your backwoods outings more comfortable and more fun, whether you go by car, by RV, or on foot. PS

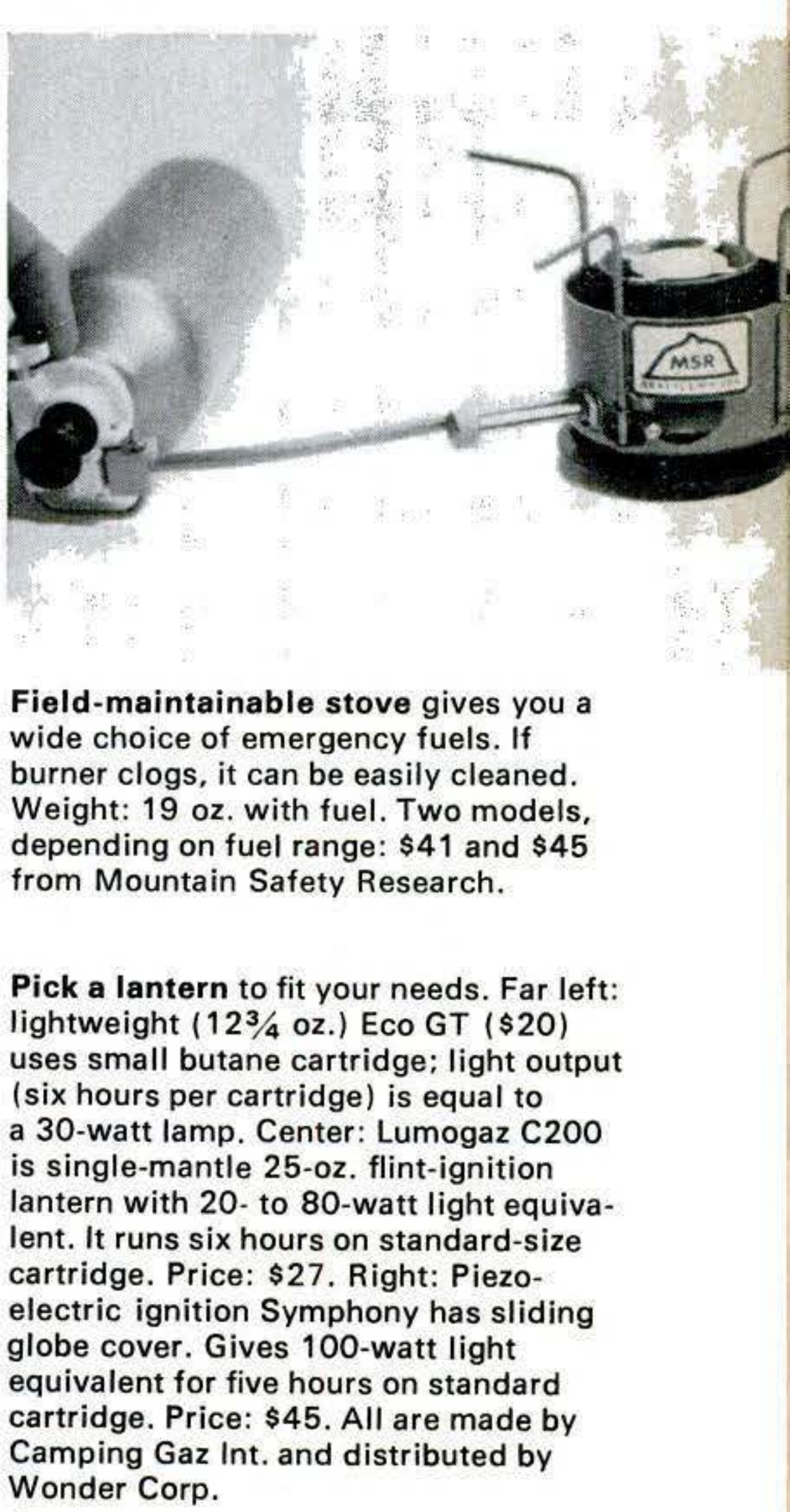
MANUFACTURERS' ADDRESSES:
Camp Trails, 4111 W. Clarendon Ave., Phoenix AZ 85019; **Cascade Designs, Inc.,** 568 First Ave. S., Seattle WA 98104; **The Coleman Co., Inc.,** 250 N. St. Francis, Wichita KS 67201; **Early Winters, Ltd.,** 110 Prefontaine Pl. S., Seattle WA 98104; **Eddie Bauer,** 15010 N.E. 36 St., Redmond WA 98052; **Flex-Lite, Inc.,** 3521 E. Kilgore Rd., Kalamazoo MI 49001; **W.L. Gore & Assoc.,** P.O. Box 1220-W, Elkton MD 21921; **Lowe Alpine Systems,** Box 189, Lafayette CO 80026; **Mountain Safety Research,** 631 S. 96, Seattle WA 98108; **Solar Works,** 4817 First Ave. S., Birmingham AL 35222; **Thermos Div.,** King-Seeley Thermos Co., Thermos Ave., Norwich CT 06360; **Wonder Corp. of America,** P.O. Box 1402, Stamford CT 06902.





Disconnect pack from frame and Gemini becomes an internal-frame rucksack. Pack is waterproofed Cordura nylon; external frame is heliarc-welded aluminum. $71; from Camp Trails.

Altimeter/barometer aids in position-finding, terrain identification, route-planning, weather prediction. Outer scale measures to 15,000 feet in 50-ft. increments. Inner scale gives inches and millibars of mercury. Thommen 16-jewel Swiss-made instrument is $69 from Eddie Bauer. Instruction booklet details many uses.



Field-maintainable stove gives you a wide choice of emergency fuels. If burner clogs, it can be easily cleaned. Weight: 19 oz. with fuel. Two models, depending on fuel range: $41 and $45 from Mountain Safety Research.

Pick a lantern to fit your needs. Far left: lightweight (12¾ oz.) Eco GT ($20) uses small butane cartridge; light output (six hours per cartridge) is equal to a 30-watt lamp. Center: Lumogaz C200 is single-mantle 25-oz. flint-ignition lantern with 20- to 80-watt light equivalent. It runs six hours on standard-size cartridge. Price: $27. Right: Piezo-electric ignition Symphony has sliding globe cover. Gives 100-watt light equivalent for five hours on standard cartridge. Price: $45. All are made by Camping Gaz Int. and distributed by Wonder Corp.

For more camping gear, turn the page

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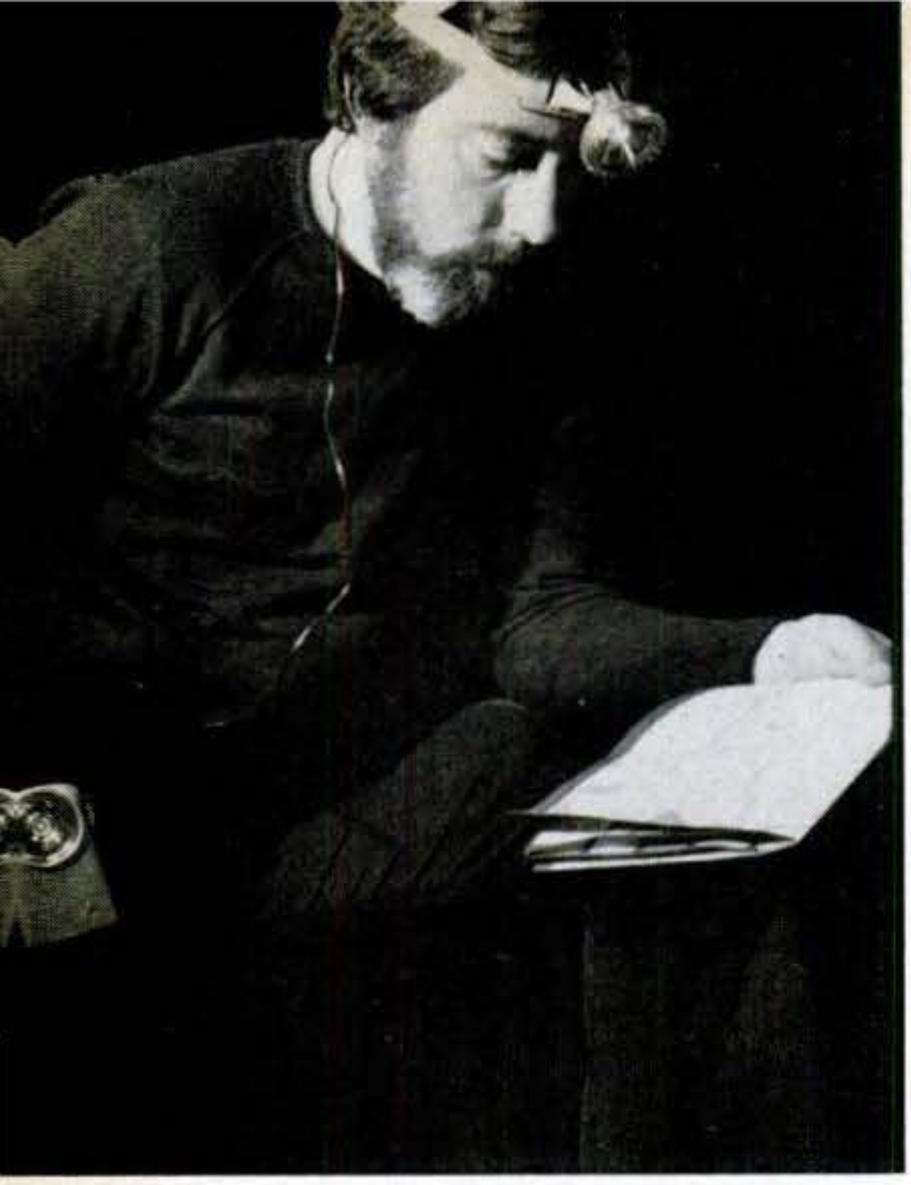
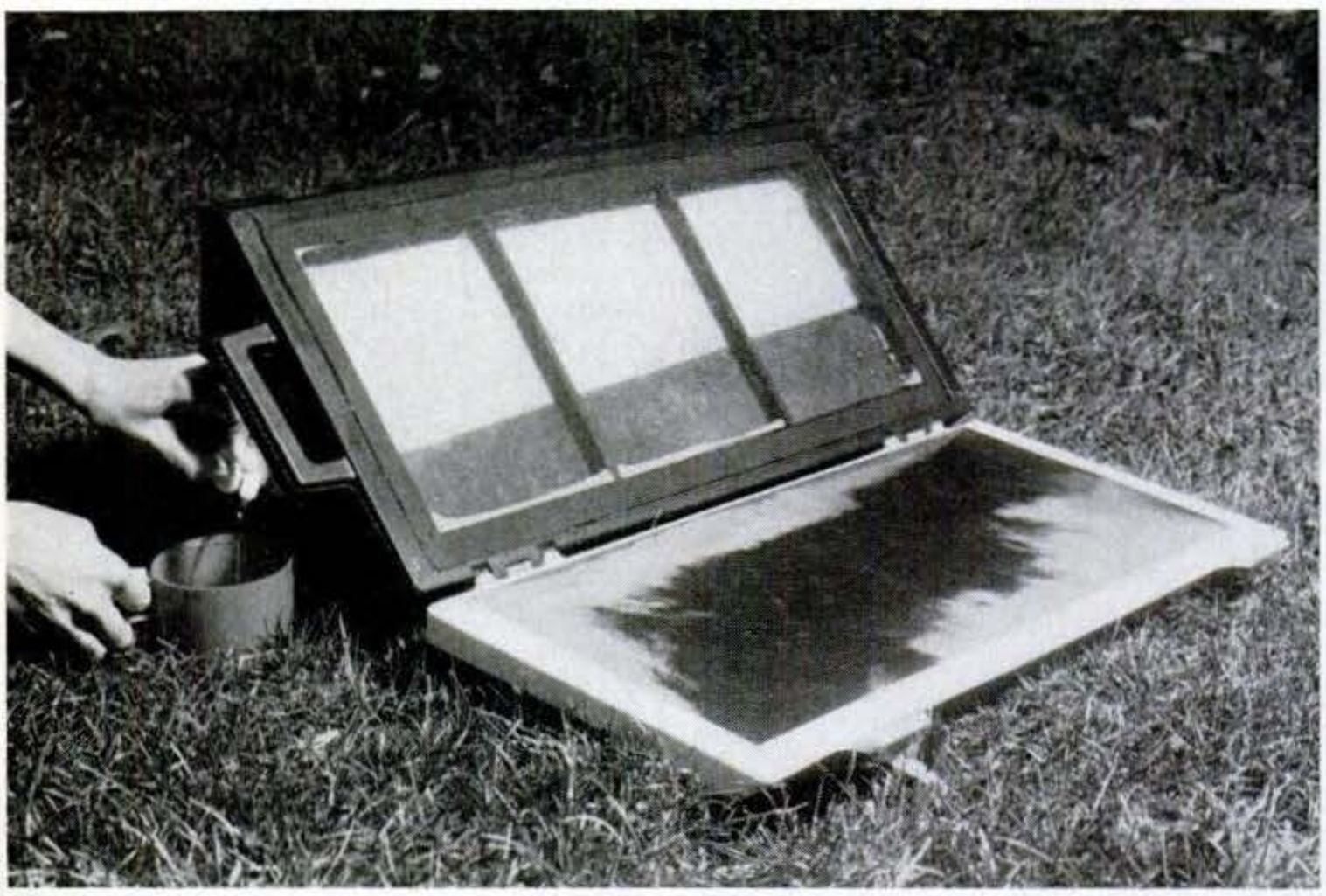
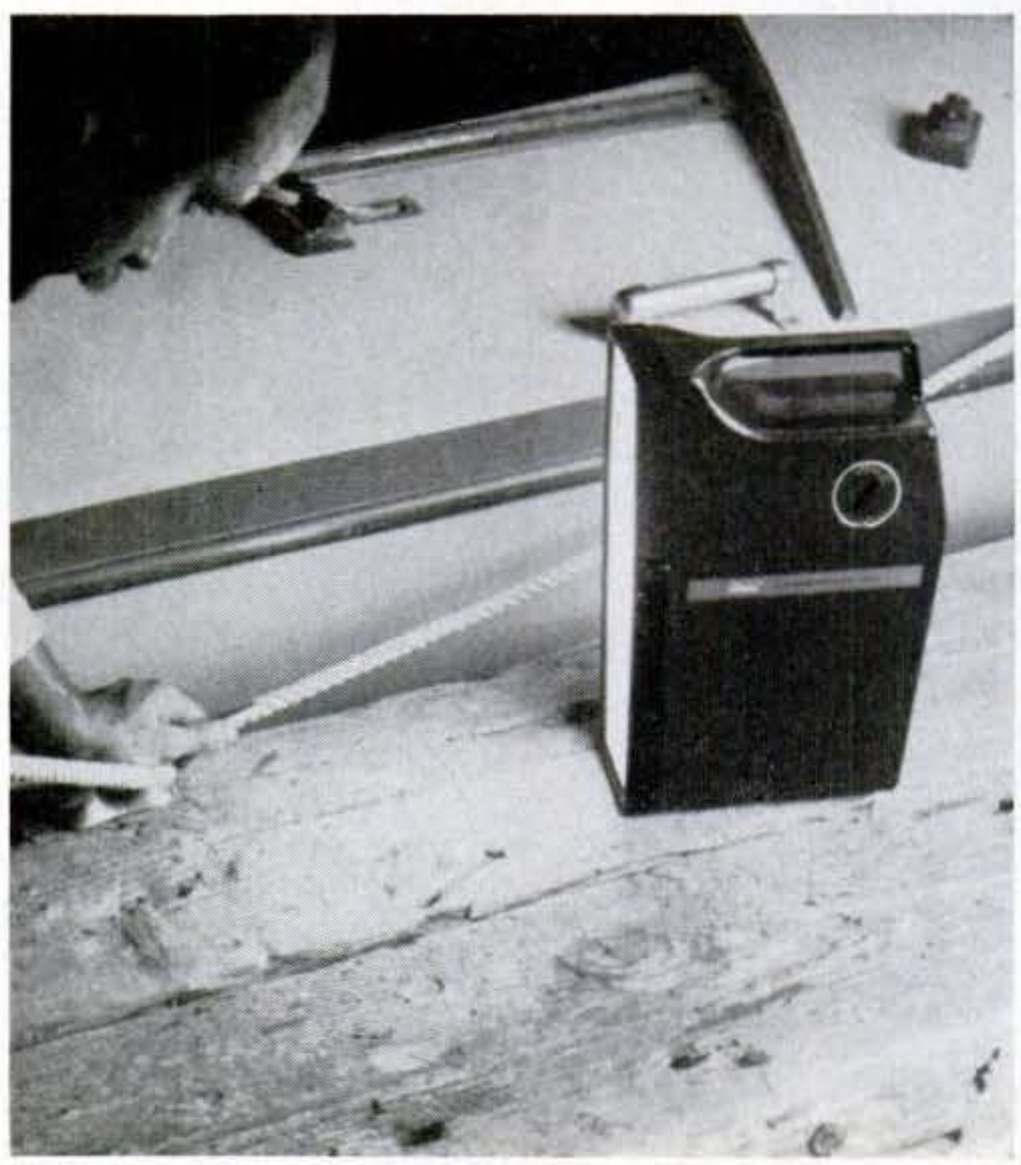


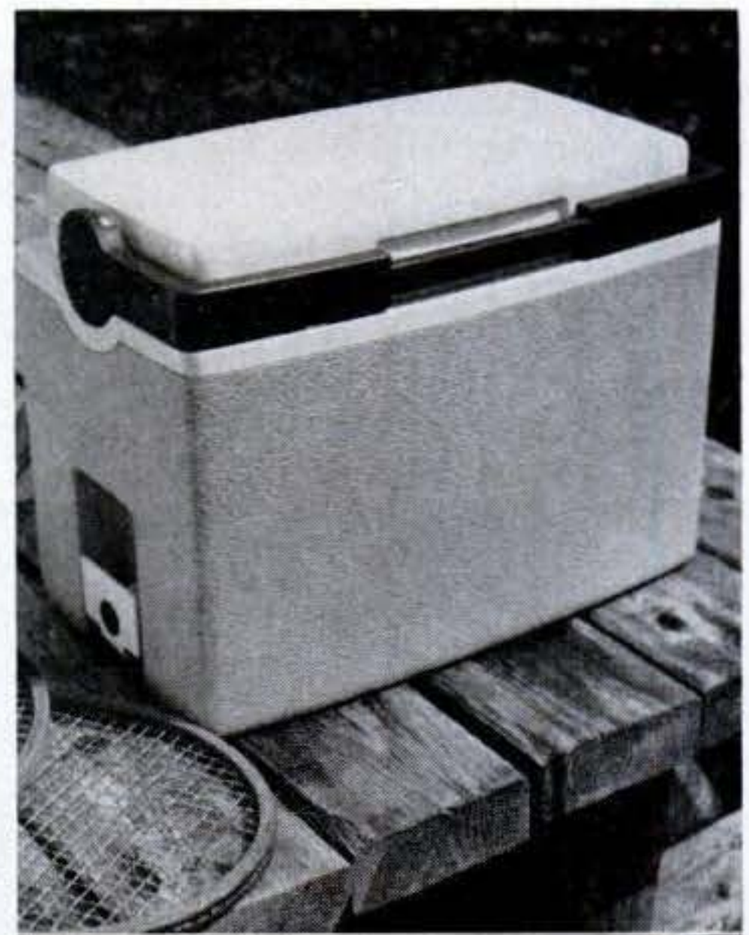
Hands-off lights illuminate task, keep both hands free. Left: Headlight comes with battery pack that's also a flashlight. Four-foot cord connects units. Headlight weighs 1 oz., pocket unit weighs 6 oz. with battery. Cross Country Lite from Wonder is $8.50; heavy-duty 4.5-V battery is $1.10. Above: Pocket light has flexible neck that lets you aim light where you want it; clip holds it to pocket or belt. Flex-Lite is 5½-in. long. Two AA cells power it; $7.95.



Solar heater that packs in car or RV can heat two gallons of water or beverages. Aim Solar Wunder so the sun enters translucent window directly and reflects off shiny lid. On a sunny summer day, liquid will reach 100°-120° F in one to two hours. In cold or cloudy weather heating takes longer. With lid closed, water stays warm overnight. $50 from Solar Works.



Rechargeable lantern with eight-watt fluorescent bulb works three ways: from its own six-volt sealed battery, from house current, or from car cigarette lighter; can be recharged from 110- or 12-volt outlets up to 150 times. The Coleman Charger SP is $50.



It's a cooler *and* a jug. New high-density polyethylene Jugler from Thermos has leakproof, stain-resistant liner and recessed faucet, which make it a handy jug. Removable food tray—(lower photo, above) makes it a fine cooler as well. Three sizes: 2-gal., $11; 3-gal., $14; 5-gal., $19.

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Plymouth Horizon

—5000-mile test of the first U.S. front-drive subcompact

Horizon's suspension and engine proved up to tackling mountainous country like this, in Pauma Valley, California.

European handling and fuel economy with American ride and room

By JIM DUNNE and RICH CEPPOS

The Plymouth Horizon glided gently over the tar strips and undulations on Interstate 15 as we headed north from San Diego. It was the first leg of a cross-country trip that would end in New York City. The plan: to live with the first U.S.-built front-drive subcompact for 5000 miles to learn what was right or wrong about its design. Would it turn out to be a car that drivers of American sedans would want to buy?

The Plymouth Horizon and its twin, the Dodge Omni, mark the beginning of a new era in American small-car design. Previous American small cars were generally just shrunken versions of larger front-engine/rear-drive sedans. The Chrysler minis, however, make use of the latest European high-efficiency technology, including front-wheel drive, transverse-mounted engine, and fully independent suspension. Chrysler is the first manufacturer to combine these features in an American car.

How well does it work? Consumer Editor Herb Shuldiner answered that best after spending a couple of days behind the wheel. "It just doesn't feel like a small car," he commented. Other PS staff members who tested the car agree: American-car buyers will feel more at home in the Horizon and Omni than in any other small car. (Everything we say here about our test Horizon also applies to the Omni; the two are identical except for minor styling variations).

The Horizon has the roomiest interior of any subcompact. The Rabbit almost matches its space, but the domestic small cars don't even

Continued

Editors Dunne and Ceppos (right) and the PS staff gave the Horizon high marks for ride and interior room.

Excellent stability, comfortable seats, roomy interior made long stints in the western states enjoyable and relaxing.

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Middle line custom interior in our test car is styled like any American sedan. Dash is clean and functional looking, with dimmer and wiper / washer switch incorporated in turn-signal lever.

The Horizon offers the advantages

come close. Based on interior and cargo space, the EPA rates the Horizon as a compact car, while the Rabbit, Fiesta, Pinto, Gremlin, and Accord are all rated as subcompacts or minicompacts.

Like the Rabbit and Fiesta, the Horizon has a transverse-mounted engine and front-wheel drive. The sideways mounting of the engine uses up the least amount of space and the front-wheel-drive layout eliminates the intrusive drive-shaft tunnel from the interior. In the Horizon, a small, central tunnel houses the shift mechanism and makes room for the exhaust pipe to pass beneath the car.

The interior feels unrestricted and airy, due to a particularly tall windshield, large expanses of glass, and a low beltline. You also sit lower in the Horizon than in other minis, which further amplifies the effect of the large windows. Chrysler pushed the dashboard almost to the base of the front window to minimize the space it takes up as well.

The front seats have enough room for a six-footer. There's ample room in the rear for two more tall people as well, even with the front seats fully back. (The spec sheets say the Rabbit has more rear leg room, but we found the Horizon roomier.) Another big complaint about small cars is that they're hard to get in and out of, so Chrysler offers the Horizon only with four doors.

The Horizon is a hatchback design, like the European minis. A cover hinged to the rear seatback lifts with the hatch door to allow easy access to the "trunk." With a pull of the release lever the rear seat folds down, though not completely flat, to convert the Horizon to a mini-wagon.

The Horizon reveals its strong American character when you get behind the wheel. It rides very smoothly, gliding over tar strips, surface irregularities, and bumps with the aplomb of a midsize car. The ride never feels harsh or choppy, even over rough and rutted cobblestone streets. However, you also get some of the vague, floaty sensation common in softly sprung big cars.

Usually, soft-riding cars are poor handlers, but not the Horizon. It took narrow mountain roads and tight switchbacks with reassuring ease, tracking just where it was pointed, ignoring bumps or dips in the turn. It also proved surprisingly agile at darting around "disaster" during our accident-avoidance lane-change test.

The standard manual steering is more precise than the systems of all but a handful of domestic cars, though it's a little rubbery and vague compared to the best of the imported small cars. It is also so light that we never wished we had power steering, though it is available.

On the highway the Horizon had confidence-inspiring straight-line stability. The buffeting from passing semis was hardly noticeable. In strong crosswinds, the Horizon was disturbed less than some larger cars we've driven. The steering also incorporates "negative scrub radius" geometry into its design. That means if traction is lost on one side of the car due to brake failure or a blowout, the steering automatically counteracts the forces that want to make the car swerve.

The Horizon's fully independent suspension system has been used on European minis, but never on an American small car. Up front there are MacPherson struts with lower control arms and an antisway bar. In the rear there are twin trailing arms and shock absorbers with concentric coil springs. Left and right suspension members are connected by a square-tube crossmember that acts as a rear antisway bar, much the same as the design found on a Rabbit. The Horizon's soft, big-car ride is accomplished by giving the suspension extra-long amounts of travel and very soft springs, so choppiness is minimized but large bumps can still be absorbed without bottoming.

Good marks for power

American drivers like smooth and abundant power as well as a smooth ride, and the Horizon gets good marks here too—at least in stick-shift form. Our California-certified test car, which had 70 hp (five less than the 49-state version), accelerated to 60 mph in about 16 seconds. A preproduction 49-state car we tested [PS, Jan.] did it in a brisk 13.5 seconds. But a Horizon we drove with the California engine and Torqueflite three-speed automatic transmission felt very sluggish up to about 25 mph. Above that speed, power was adequate. A Chrysler transmission engineer explained that small, high-revving engines don't put out enough torque at low rpm to give good low-speed acceleration with an automatic transmission. But the difference between automatic- and manual-shift Rabbits isn't nearly as great.

Chrysler buys the four-speed manual transaxle (the combination transmission/differential) and the engine "short block" (engine block, crankshaft, pistons, rods, and cylinder head) from Volkswagen. They are both used on the Rabbit, but the Chrysler version of the engine has a longer stroke, which increases its displacement to 1.7 liters from 1.6. The longer stroke gives the engine a bit more low-speed torque, so acceleration is improved at low- and mid-range speeds.

Chrysler fits the VW short blocks with its own manifolds, carburetor, alternator, water pump, and Lean-Burn electronic ignition system. The Horizon introduces Chrysler's new Hall-effect distributor, which operates on the principle of a magnetic field, changing the potential of a conductor without regard to the speed of the field. It provides more reliability and uses less energy than other systems, so four-cylinder engines can now get full ignition power at slow starting speeds.

Chrysler also fits the Horizon with a relatively high axle ratio (3.5:1 on 49-state cars, 3.7:1 in California) so the engine runs slower and more quietly at highway speeds.

Despite the California emission controls fitted to the engine, our test car suffered no drivability problems during our test. It started on the first try in temperatures

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of European small-car design to Americans put off by lack of refinements

that ranged from 70° F down to the 20's. In fact, we thought it was a 49-state model until we got back to New York. Its fuel economy was good as well. The EPA rates the California engine at 28 mpg combined highway-city driving (35 highway/24 city). For the first 3700 miles we recorded an average of 28.34 in mostly highway driving. The 49-state car is rated 30 mpg in combined driving (39 highway/25 city).

Trim is domestic

Though its fuel economy rivals any mini car, the Horizon can be outfitted almost as elaborately as an American midsize sedan. There are three basic interior-trim levels, and they are totally American in style. The dash is cleanly styled, the doors are fully upholstered, and there is no painted metal showing anywhere in the interior. Carpeting, AM radio, cigarette lighter, and a folding rear parcel shelf are standard. The custom option adds wood-grain accents to the dash, and plusher seats. The premium interior rivals a top-of-the-line Volare Premier for luxury: There are reclining low-back bucket seats in vinyl or cloth-and-vinyl, carpet on the door panels, hockey-stick arm rests, and a color-keyed console. You can also add a host of comfort and convenience options, like power steering and brakes, factory installed air conditioning, AM/FM stereo, rear-window wiper/washer and defroster, extra sound insulation, and more. Exterior options include numerous chrome moldings, 19 color combinations (five of them two-tone), wood-grain side appliques, tape stripes, and a vinyl roof. There is also a heavy-duty suspension, and five choices of radial tires. All of the exterior and interior trim packages can be mixed and matched.

Problems and praises

As we expected, living with the Horizon revealed its weaknesses as well as its strengths. We found a number of problems in both design and assembly that need attention.

The most annoying is an awkward gas pedal. It was hard to depress through the first quarter of its travel, then moved freely. It was hard to regulate, especially at highway speeds, where it required much pressure and conscious effort to control without jerkiness. The shift mechanism was also balky. Most of the time, the only way we could get it to engage first gear was to jiggle it back and forth in neutral. Both the gas-pedal and shifter problems were present on other early production cars we drove.

Though our car was fitted with the optional sound-deadener package, it was not as quiet as most American sedans. It also suffered from a bit of engine buzzing during deceleration from highway speeds.

The fit and finish of our car were not as good as we would have liked, either. The rear-seat release cable fell out of its mounting, and trim loosened up on the dash. The steering wheel had ugly mold marks on the spokes and looked cheap and out of place in the car's middle-line custom interior. There was a big gap between the dome light and the fiberboard-type headliner. Another problem was the outside door handles. They look like the common pull-type, but actually must be squeezed, an awkward and unnatural movement. They should be redesigned. Raising the low driving position about an inch would allow the driver to see the tips of the front fenders. Sitting on a cushion made the car seem as small and maneuverable as it really is. We also had problems with the locking screw-on gas cap, which was inconvenient and almost impossible to loosen.

Our biggest problem was a mechanical one. At 3756 miles, during our track-testing session, the left front drive shaft fell off. Apparently someone at the factory didn't tighten the bolts properly and they loosened slowly as we drove cross-country. None of the other early production cars, we are told, has had this problem.

But early production problems aside, we think the Horizon is a very good car. It is head-and-shoulders above the domestic subcompacts in almost every category, and in most respects is as good as the best European cars—and superior to them in ride and room.

The Horizon offers all the advantages of modern European small-car design to Americans who were formerly put off by stiff ride, plain interiors, and a lack of comfort and convenience items. It's a big step in the right direction for American automakers and car buyers. Since our cars will keep getting smaller to meet the 1985 fuel economy laws, it's reassuring to know that American companies are capable of building small cars that American buyers will like. PS

Plymouth Horizon—specs, dimensions, and test results

	Plymouth Horizon
DIMENSIONS (inches)	
Wheelbase	99.2
Overall length	164
Overall height	53.4
Overall width	66.2
Track, F/R	55.5/55.1
Ground clearance	5.5
Front head room	38.3
Front hip room	52.6
Front leg room	41.8
Rear head room	37.4
Rear hip room	52.4
Rear leg room (min.)	33
Min. rear knee room	−1.3
Couple distance	29.4
SPECIFICATIONS	
Engine type	4 in-line OHC
Displacement (cu. in./L)	104.7/1.7L
Compression ratio	8.2:1
Carburetion	2 bbl.
Net hp @ rpm	70 @ 5600*
Net torque @ rpm	85 @ 3200*
Transmission	4-speed Manual*
Axle ratio	3.7
Tire make	Michelin
Tire type	X Z X Radial
Tire size	P165x75R13
Steering	Manual
Overall steering ratio	22:1
Turns lock to lock	4
Turn diameter (ft.)	34
Front suspension	MacPherson struts; coil springs
Rear suspension	Semi-independent trailing arm
Front stabilizer-bar diameter (in.)	0.866
Rear stabilizer-bar diameter (in.)	None
Emission-control equipment	Exhaust-gas recirculation, catalytic converter, air injection
Brakes	Power
Brake type	Disk/drum
Brake swept area (sq. in.)	197.5
Fuel tank (gal.)	13
Trunk space (cu. ft.)	10
Liftover height (in.)	29.9
Curb weight (lb.)	2137
F/R weight distribution (%)	62/38
Basic price	$3706
Price as tested	$4317

Major options on test car:

Custom interior ($62), power brakes ($66), cargo area carpet and sound insulation ($43), console ($51), rear defroster ($81), rear wiper ($59), side stripe ($66), sill molding ($19), wheel-lip molding ($27), belt molding ($16), rally wheels ($73)

TEST RESULTS	
Acceleration (sec.)	
0-60 mph	16
25-70 mph	20.3
Brake test (cool)	
Stopping distance (ft.)	144
Pedal pressure (lb.)	100
Disk temperature (°F)	133
Brake test (hot)	
Stopping distance (ft.)	138
Pedal pressure (lb.)	100
Disk temperature (°F)	660
Interior noise @ 60 mph (dBA)	76
Handling test (mph)	63.6
Maneuverability (mph)	28.1

TEST CONDITIONS: Temperature 50°F; relative humidity 62 percent; barometric pressure 30.0 inches.

*California engine

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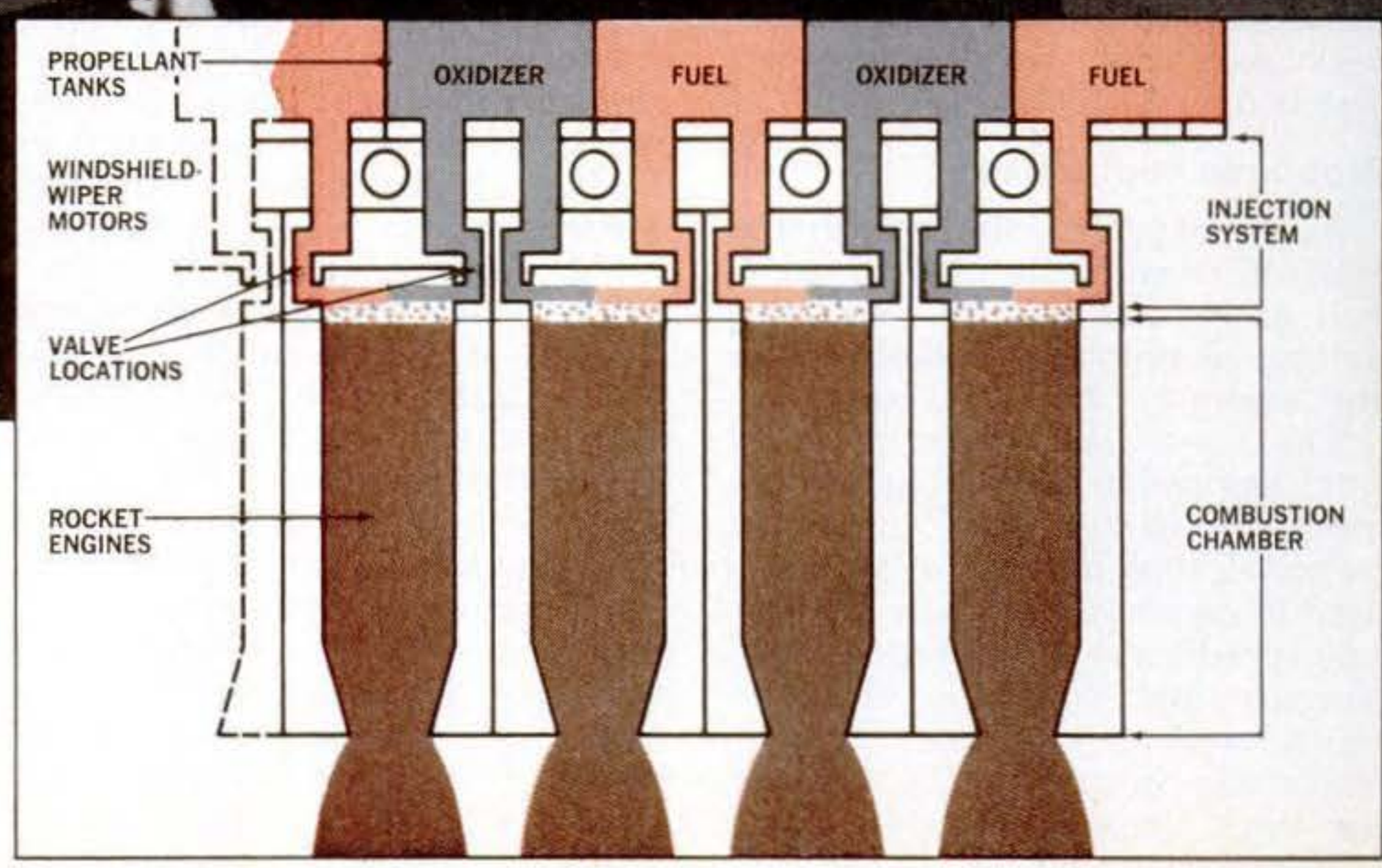
Bargain-basement rocket

–a low-technology "truck" for cheap shots in space



Smallest OTRAG module capable of flight has four engines and two fuel (BR) plus two oxidizer (OX) tanks. At top of each engine is container for nicad batteries and hybrid computer. Photo and diagram at right show how tanks and engines are staggered so each tank can feed two engines in a circular, wrap-around configuration. Diagram also shows elements of the injection system.

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What are automobile windshield-wiper motors doing in a space vehicle?

By JOHN DORNBERG

STUTTGART, WEST GERMANY

One prominent West German aerospace expert was willing to wager "a stein of stale beer against an entire brewery that the thing will never get off the ground."

Another described it as a "bundle of asparagus," and predicted disdainfully, "Asparagus can't fly."

Both were proved wrong last May when the "asparagus" not only got off the ground with a deafening roar but actually whooshed to an altitude of more than eight miles in its first flight test.

"The thing" has been called other names besides "asparagus"—the bargain-basement rocket, the discount rocket, the Volksrocket, and a space truck. More precisely, it is "a throwaway heavy-launch vehicle," designed to place communications, reconnaissance, educational, and other satellites into either low-earth or geostationary orbits for only $4 million—much less than the net production cost of existing or other planned launchers such as NASA's Deltas, Centaur, Titan III C and Space Shuttle, or the Franco-German Ariane.

Financed and being built privately without government money, the OTRAG rocket, as it is also called, is intended to corner the promising satellite market of the 1980's and '90's, in addition to reaping potentially huge profits for its inventors and builders. But even if it never achieves those goals, the OTRAG launcher is already making a stir in the rocketry business with its ingeniously innovative concepts and radical departure from traditional space technologies.

Among these, to name but a few, are modular, building-block clusters of small rocket engines incorporating mass-produced commercially available components such as automobile windshield-wiper motors and ball valves used in the chemical industry; a blow-down feed system instead of turbopumps; and common diesel oil as fuel with nitric acid as an oxidizer.

All this—and more—is the brainchild of Lutz T. Kayser, a 38-year-old West German aeronautical and propulsion engineer who has spent more than a decade designing and developing this unique space vehicle, and has registered 31 personal patents in the process.

OTRAG is an acronym for *Orbital Transport und Raketen Aktiengesellschaft,* which translates neatly and literally as "Orbital Transport and Rocket Corporation." Kayser is the Stuttgart-based company's president and chief executive officer as well as its driving scientific and technical force. The chairman of OTRAG's board is Kurt H. Debus, former director of NASA's Kennedy Space Center and a long-time associate of Wernher von Braun—back to the days of the V-1 and V-2 at Peenemunde.

Their business, as they envision it, is purely and simply transportation—"transportation and trucking in space of any kind of peaceful satellite" at economically sensible prices.

Marketing to the Third World

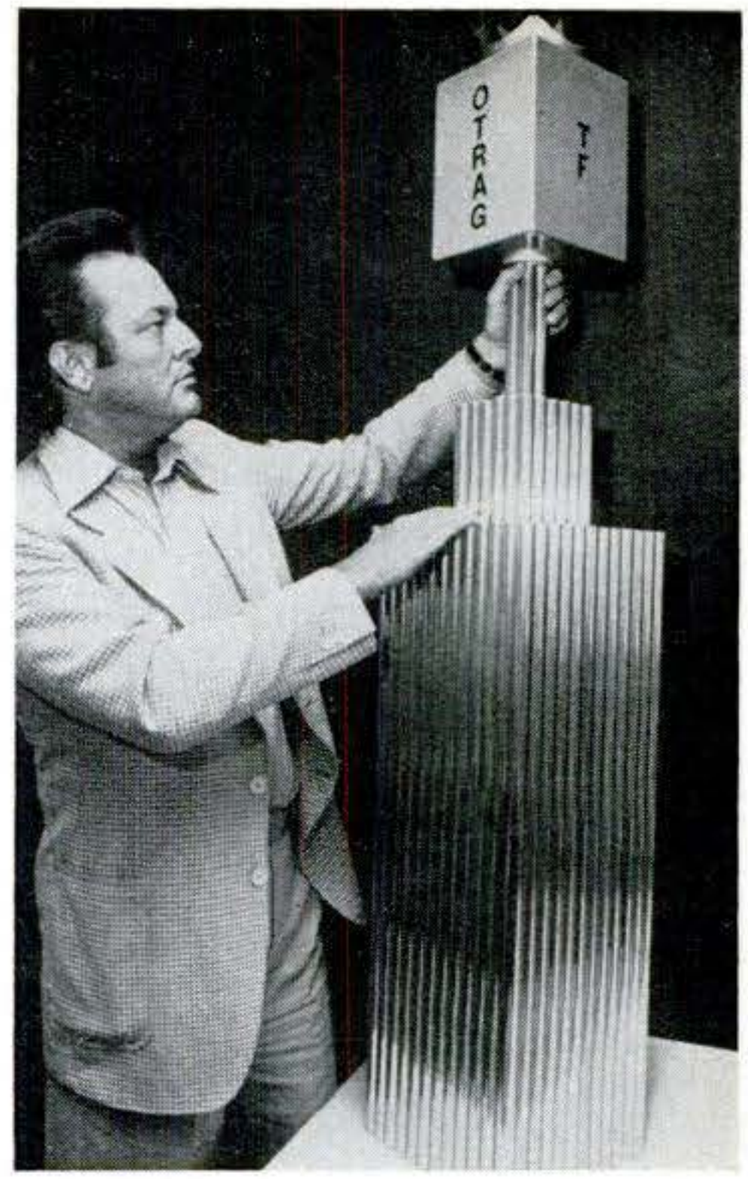
After 1981, when they expect their vehicle to be fully operational, they will be aiming specifically at the market of Third World and less-developed countries, which, so Kayser and Debus predict, will then have a crying need for Landsats, Earthsats, and large-volume direct-transmitting communications and educational TV orbiters such as the experimental American ATS-6.

"Some 25 less-developed countries have already expressed interest in their own observation and recon satellites," Kayser told me when I visited him here recently. He pointed also to a recent study by ESA, the European Space Agency, which estimates a need for at least 200 commercial orbiters in the 1980's.

"The problem," he said, "will not be building those satellites, but getting them up there cheaply."

Kayser has been dabbling with rockets since his teens. He formed the German Society for Rocket Technology and Space Travel while a 17-year-old Stuttgart high school pupil, and perfected the world's smallest liquid-fuel propulsion unit —a half pound of thrust—while still a student and protege of German rocketry pioneer Prof. Eugene Sanger at Stuttgart Technical University. He has been pursuing his dream of a low-cost launcher since the 1960's.

"The trouble up to now," he said, "was that space has been a matter either of prestige or of military requirements, so no one gave a damn about its costs. Scientists,



Inventor of space truck, Lutz Kayser, holds model of big OTRAG launcher. Photo shows how clustered first, second, and third stages are arranged inside one another like nested boxes. After outside first stage has burned out, second stage moves out of it on rollers, as does third stage with payload when second stage burns out. Each tank on model actually represents six; full-scale unit will have 492 tanks and engines.

engineers, and technicians were literally encouraged to think in complicated and expensive terms, not simple and cost-cutting ones.

"Did you know, for example, that NASA allocated about a half million dollars just to develop a ballpoint pen for the Apollo missions that would work under conditions of weightlessness when, after all, an ordinary pencil would have done the trick just as well?"

Kayser began his quest by conducting a series of feasibility studies for the West German ministry of science with a minuscule group of engineers, most of them friends from college.

Government help—for a time

That program was funded—with about $1.8 million over a period of about three years—by the Bonn government. But by 1974 the government had lost interest and the fiscal tap was turned off.

By then, however, Kayser had a well-developed design and a uniquely simple engine. During the next three years—until spring 1977—it went through more than 2600 successful test firings on a stand rented from the quasi-governmental Ger-

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man Aerospace Research and Experimental Station at Lampoldshausen, about 40 miles north of Stuttgart.

During this development period, Kayser set up the OTRAG company, which thus far has raised $26 million from 600 individual investors.

Recently, Kayser and OTRAG negotiated a highly unusual agreement—now the subject of considerable controversy—with the African Republic of Zaire and its ruler, President Mobutu Sese Seko, for the 25-year rental of a 38,600-square-mile plot of land: a territory larger than the state of Indiana. There, OTRAG has established its near-equatorial launch site and the largest test range in the world, a sort of "private Cape Canaveral of Africa."

From there, last May 17, Kayser and his team launched the smallest flight-worthy module of their rocket.

That basic, single-stage OTRAG booster, about 30 feet long from the tip of its nose cone to its exhaust nozzles, has two fuel and two oxidizer tanks and four clustered engines, each developing 6600 pounds of thrust. Though its tanks were filled to only 20 percent of their capacity, it soared without the slightest hitch to an altitude of more than 43,000 feet.

"Even after all those test-stand firings," said Kayser elatedly, "we didn't expect the first trial launch to go quite that smoothly."

Because it did, a two-stage experimental version with 12 engines clustered in the first stage and four in the second will be launched this spring as soon as the Zaire rainy season is over. Plans call for a three-stage OTRAG shot—and entry into low-earth orbit with a dummy payload—no later than 1979 or early 1980.

Shortly after, if everything has gone well, OTRAG expects to launch its first full-sized rocket—a huge vehicle more than 120 feet long and 25 feet in diameter—with a communications satellite for Zaire. It will have clusters of no less than 600 engines, each with the same basic 6600 pounds of thrust. It is designed to put a ten-ton payload into low-earth orbit, or four tons into transfer orbit, or a two-ton satellite into geostationary orbit.

$4 million per shot

That will be Kayser's biggest and most expensive booster, which, he maintains, he can build and launch at around $4 million per unit, though he says candidly "we intend to sell it at a market-oriented, profit-making price." He predicts that this will be approximately $7 million for a Delta-class OTRAG vehicle, $12 million for one in the Atlas-boosted Centaur category, and $15 million for one comparable to a Titan III-C or the Space Shuttle.

Prices like those would undercut anything now available or planned.

Launch-cost estimates for the European Space Agency's Ariane are currently around $40 million a shot, though it will have only half the weight capacity in near-earth and geostationary orbits—4.5 tons and one ton respectively—of Kayser's biggest launcher. But the price may end up considerably higher, provided the Ariane is even technologically feasible. Thus far more than $1 billion has been spent on Ariane's complex liquid-oxygen and liquid-hydrogen propulsion system, and the first test-stand firings are not scheduled until 1979.

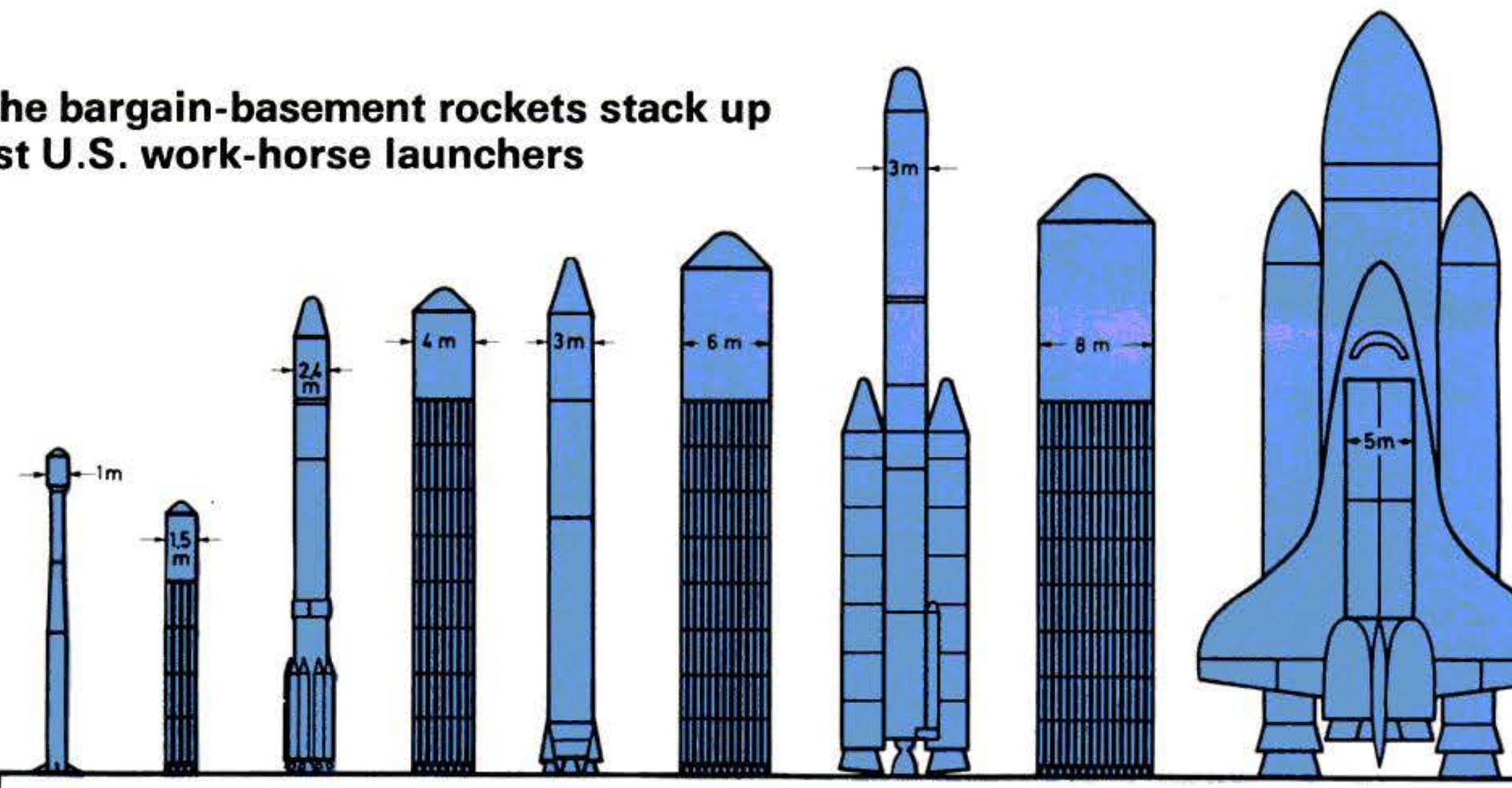
The OTRAG vehicle will even be cheaper than the Space Shuttle, though Kayser predicts that the two will compete against each other in only 20 percent, roughly, of potential missions. NASA currently charges client nations and business groups up to $25 million per launch. In 1971, it promised that costs would be cut in half when the Shuttle became operational, but European satellite experts fear that it may go down by only 25 percent.

"What we want to do," said Kayser, "is bring launching costs down to a commercially sensible ratio to satellite costs. As satellites themselves get progressively cheaper, it will be like transporting bags of cement in a Rolls-Royce. To carry cement you ought to use a truck, and that's what we are building—a space truck."

Building-block design

Among the most important fea-

How the bargain-basement rockets stack up against U.S. work-horse launchers



ORBIT	SCOUT-D USA	OTRAG-200 PRIVATE	DELTA 3914 USA	OTRAG-2500 PRIVATE	CENTAUR USA	OTRAG-5000 PRIVATE	TITAN III-C USA	OTRAG-10000 PRIVATE	SPACE SHUTTLE USA		ORBIT
300 km	200	200	2 500	2 500	6 500	5 000	15 000	10 000	30 000	KG	300 km
36 000 km	–	40	440	450	910	1 000	1 500	2 000	4 000	KG	GEOSTATIONARY

OTRAG rockets of varying sizes are contrasted with familiar space vehicles in scale drawings indicating maximum payload widths. Chart figures are payload weights, in kilograms, that each vehicle can loft to low and to geostationary orbit.

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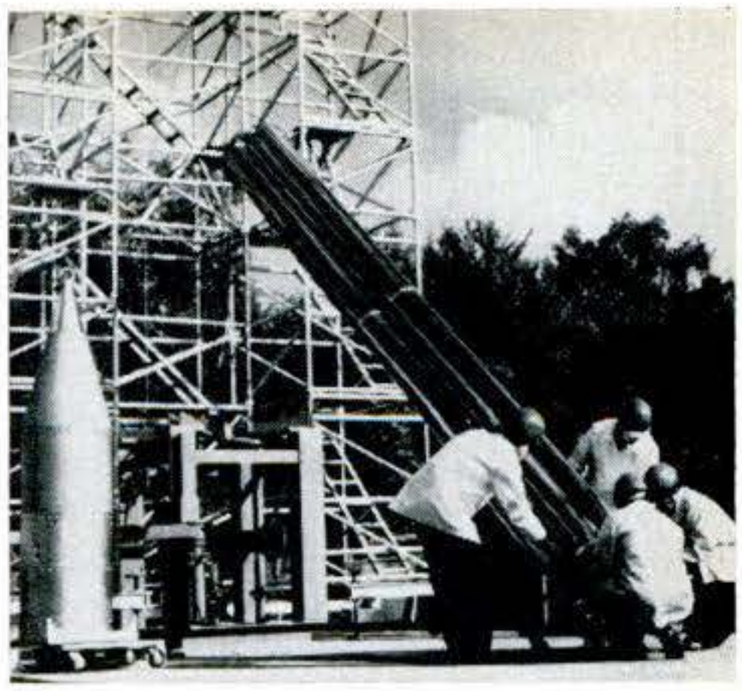

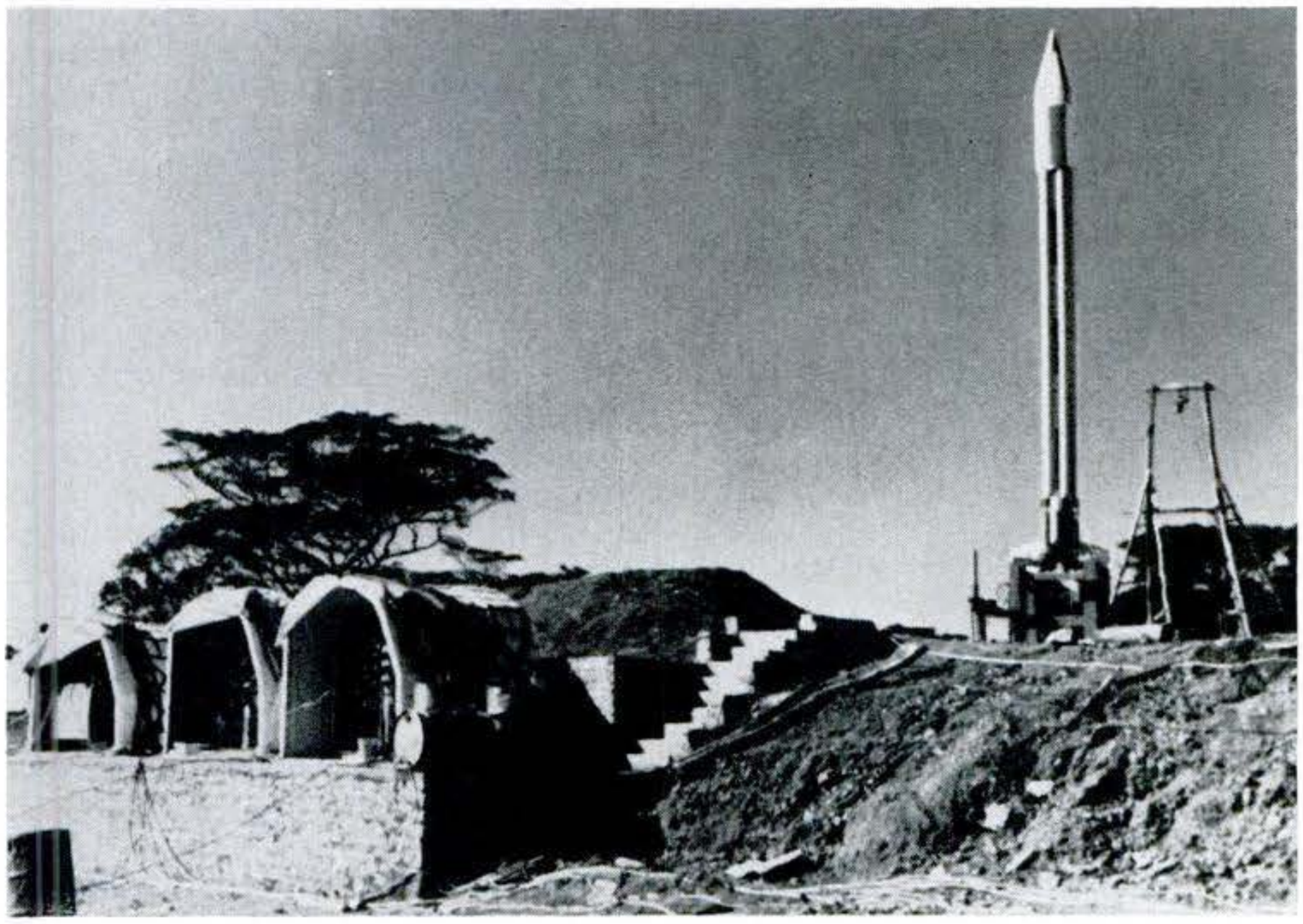

Moving towards a launch: Only movable parts in OTRAG engine appear in photo above, left. In assembly on left are two ball valves, like ones used in chemical industry, which control flow from propellant tanks, with windshield-wiper motor that actuates them. Disassembled unit at right also reveals power compartment nicads and microprocessor that throttles engine to control pitch and yaw. Photo above shows assembly of basic OTRAG module; propellant tanks are being hoisted at test stand in Lampoldshausen. Nose cone is at left. Finally, first test vehicle is ready for firing from OTRAG launch pad in Zaire (photo at left). Note hoist made of logs. Air-freight containers in foreground hold propellant mixture and are air-shipped from Germany to Zaire.

tures of the OTRAG is its modular, or building-block, design. Each engine is identical in size, shape, components, electronics, performance, and thrust. It is fed by two identically shaped propellant tanks, one for fuel, the other for oxidizer. They are joined in a vertical parallel construction and are set atop the engines in such a fashion that each fuel and each oxidizer tank feeds into two separate but adjacent propulsion units, so that for four engines there must be two fuel and two oxidizer tanks, for eight engines there would be four of each, and so on.

Each tank unit, made of 12-inch-diameter pipeline steel tubing, is about 10 feet long. To increase capacity, the tanks are lengthened by joining the required number of 10-foot sections, with nozzled bulkheads between. The more thrust that is needed, the more engines and tanks there are, and the longer the tanks.

The four-engine test unit launched last May had four tanks, each 20 feet long with one bulkhead in each. The biggest booster, with its 600 engines, would have 600 tanks, each 80 feet long, with seven bulkheads per tank.

The advantages of the system are numerous. The modules can be clustered according to the requirements of each mission and payload. All parts are interchangeable and can be mass-produced. The use of small tank units with internal bulkheads reduces propellant sloshing and provides for greater stability in liftoff and guidance.

Components are standard

Most of the system's components are industrially available. They were intended and are used for entirely different, non-space-related purposes.

The valves that control propellant inflow to the radial injection system of each engine are off-the-shelf ball valves used in the chemical industry. They had to undergo some modification, however, such as the addition of an inlet nozzle for loading the vehicle, to adapt them for use in the launcher.

Each pair of valves is actuated by an automobile windshield-wiper motor like that used in most West German passenger cars.

The steel propellant tanks, less than one millimeter thick, are regular pipeline tubes manufactured by a German steelmaker, though they have to undergo a special cold-forming process.

Solutions like these have enabled OTRAG to adhere to the cost prognoses it made years ago.

"This is one system that is not going to end up costing double or triple the initial estimates by the time it is fully operational," Kayser insisted. "Certainly, we have had some inflation here and the cost of some components will rise, but not enough to make a significant change in the launcher's price."

Low-cost propellants

In keeping with the low-cost philosophy, the OTRAG rocket uses the most inexpensive propellant combination imaginable—diesel fuel and nitric acid—which is delivered to the engines by a blowdown feed system instead of by turbopumps and separate fuel lines.

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The mixture costs much less than those commonly used in rockets. The tanks are filled with about 40 percent compressed air, which forces the propellant through the valves and into the injection system by means of adiabatic expansion (without gain or loss of heat). This system is not only considerably less expensive, but circumvents the complexities and frequent troubles associated with turbopumps, fuel lines, and active control devices. Moreover, the choice of mixture virtually dictated the blow-down concept and vice versa.

Among rocketry experts it had long been axiomatic that this propellant combination does not provide stable burning, and that it leads to pogo oscillations in conventional rocket structures with their long fuel lines and pumps. The blow-down system, with direct feeding into the combustion chambers from two parallel tanks, avoids the pogo effect and provides for stable burning.

But Kayser admitted candidly that "it was our greatest problem and cost us thousands of dollars before it worked." The system went through hundreds of test-stand firings before stability was achieved.

Crucial to the breakthrough was the radial injection unit, which went through countless modifications before it provided the right vapor mixture of fuel and oxidizer. OTRAG treats it as one of the company's biggest secrets and will give even unsophisticated visitors only a fleeting glimpse of the complex interior structure of aluminum baffles and little outlet holes. "Injection systems," said Kayser, "are the real 'black magic' of rocketry science. Because we are a commercial enterprise whose principal capital is a five-year headstart in know-how, we can't reveal how ours functions."

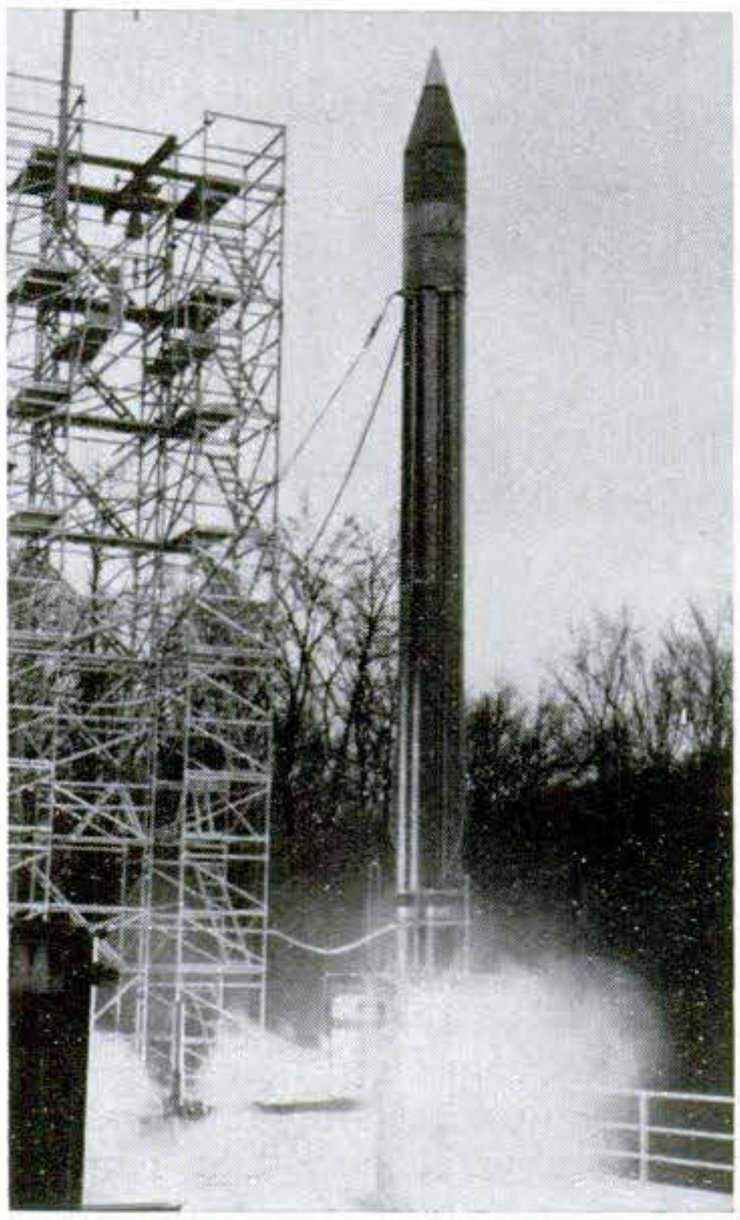
Throttling for control

Another important feature of OTRAG's "space truck" is that pitch and yaw control is achieved not by gimbaling the engines, but by a throttling capability in each and every propulsion unit.

This is the primary purpose of the two ball valves and the wiper motor that regulate propellant flow in each engine. They can be moved to open, half-open, and shut positions.

The electronic and guidance systems are decentralized. An inertial navigation platform and computer with "an engine-selection logic" in the payload section determine altitude and orientation and transmit coded signals, "via a single electrical conductor, not a whole trunk of cables," to small microprocessors in each engine unit. These minicomputers then actuate the wiper motors and valves, which throttle engines on one side or another to control the vehicle.

Each of these microprocessors, together with its own power supply —nickel-cadmium batteries—is encased in a synthetic-resin block, one per engine, that fits into the valve and wiper-motor compartment. The batteries also supply power to the wiper motors.



Hot-firing test of OTRAG takes place at stand of German Aerospace Research and Experimental Station at Lampoldshausen, 40 miles from Stuttgart.

The throttling solution was dictated partly by the cluster design and the unorthodox construction of the vehicle, partly also by cost and reliability considerations. By not gimbaling the engines, OTRAG has been able to avoid the highly complex, expensive, and often failure-prone hydraulic and pneumatic swivel and hinge mechanisms of conventional rockets.

Throttling will be tested in flight in the planned two-stage launch this spring.

Stages are nested

Instead of being stacked atop one another, the stages of the OTRAG launcher are clustered inside one another like a set of nested boxes. Although the second and third stages are smaller in diameter and fit inside, they have the same total length as the first.

As the outer, or first, stage burns out, the second one layered within it ignites and moves on rollers out of the burned-out skin of the first stage. The same procedure is followed with the third stage, which carries the payload.

This arrangement for the stages doesn't make for a particularly handsome vehicle. It will be relatively short and fat. Moreover, since OTRAG is currently favoring a square cross-section design for the launcher (though a hexagonal arrangement is also being considered) it will not look like any other rocket. It does indeed resemble a bundle of asparagus.

Payload is wider

But there are several advantages to this scheme. By not stacking the stages, Kayser eliminates the need for complex and expensive separation mechanisms. He theorizes that it may also assure more accurate orbit insertion with a minimum of second- and third-stage guidance, "because the stages will be shooting like shells from the barrel of a gun."

But beyond that, the arrangement allows for extraordinarily wide payload diameters—almost 26 feet compared with 16 feet for the Space Shuttle.

"Voluminous, wide-diameter payloads will be very much in demand after 1980," Kayser told me. "These will be bigger communications satellites with greater amplification and capacity for direct transmission to home TV receivers."

Ingenious and uncomplicated as it all sounds, there are of course some penalties and disadvantages to the whole OTRAG system, the primary one being the vehicle's weight, which will be double that of existing launchers with comparable payload capacities. It results both from higher structural and propellant weights. Since the fuel mixture provides less thrust per pound than others used in conventional rockets, it must be carried in greater quantity. Thus fuel accounts for about 85 percent of the total launch weight, which, in the case of the biggest vehicle, will be well over 1000 tons.

But this disproportion between launch weight and payload weight doesn't faze Kayser at all.

"It is not an issue," he said. "What counts is the proportion be-

[Continued on page 186]

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Versatile new **routers** –tools that turn you into a craftsman

Shown, back row: Sears 1½ hp, $100; Skil 295, ¾ hp, $47; Black & Decker 7620, 1 hp, $75. Second row: Rockwell 4620, ⅝ hp, $50; Stanley 91260, 1½ hp, $99; Wen 1700, ⅝ hp, $40. Front: Shopmate 2700TO, ⅝ hp, $61.

By A. J. HAND

If you think a router is just a tool for making a bunch of fancy grooves and cuts, you're way off the track.

The router is probably the most versatile tool you can own. Sure, it makes designs and does lettering, but it does a lot of other things well, too.

To start, the router is an expert in joinery. Dadoes, rabbets, dovetails, mortise-and-tenons, half laps, end laps, splines, tongues-and-grooves are all easy fare for the router.

Want to mortise some hinges? Trim veneers and laminates to size? Cut a recess for an inlay? Carve and engrave? Make your own moldings? All that is easy, too.

But a router can do more. It can turn furniture legs, complete with spirals, flutes, and tapers. It can cut a circle out of a sheet of ply-

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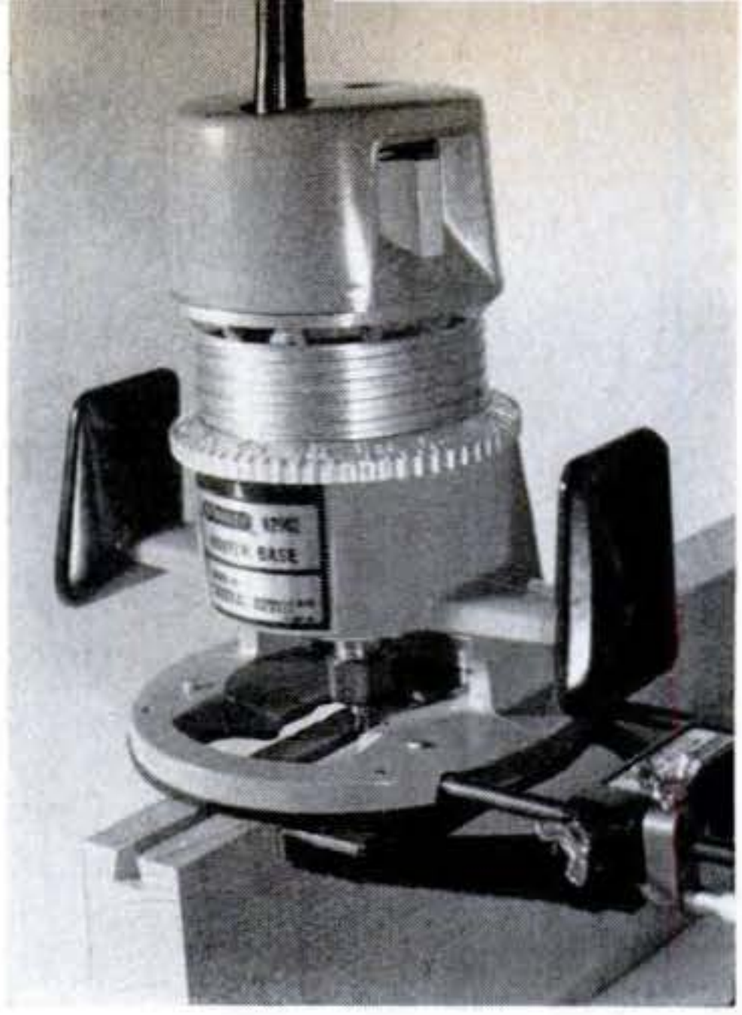
wood. Or make a perfect cutout for an outlet box in a piece of wall paneling.

It can let you make dozens of duplicate pieces, automatically. It can plane a piece of wood. And after all this work, it can even sharpen its own bits.

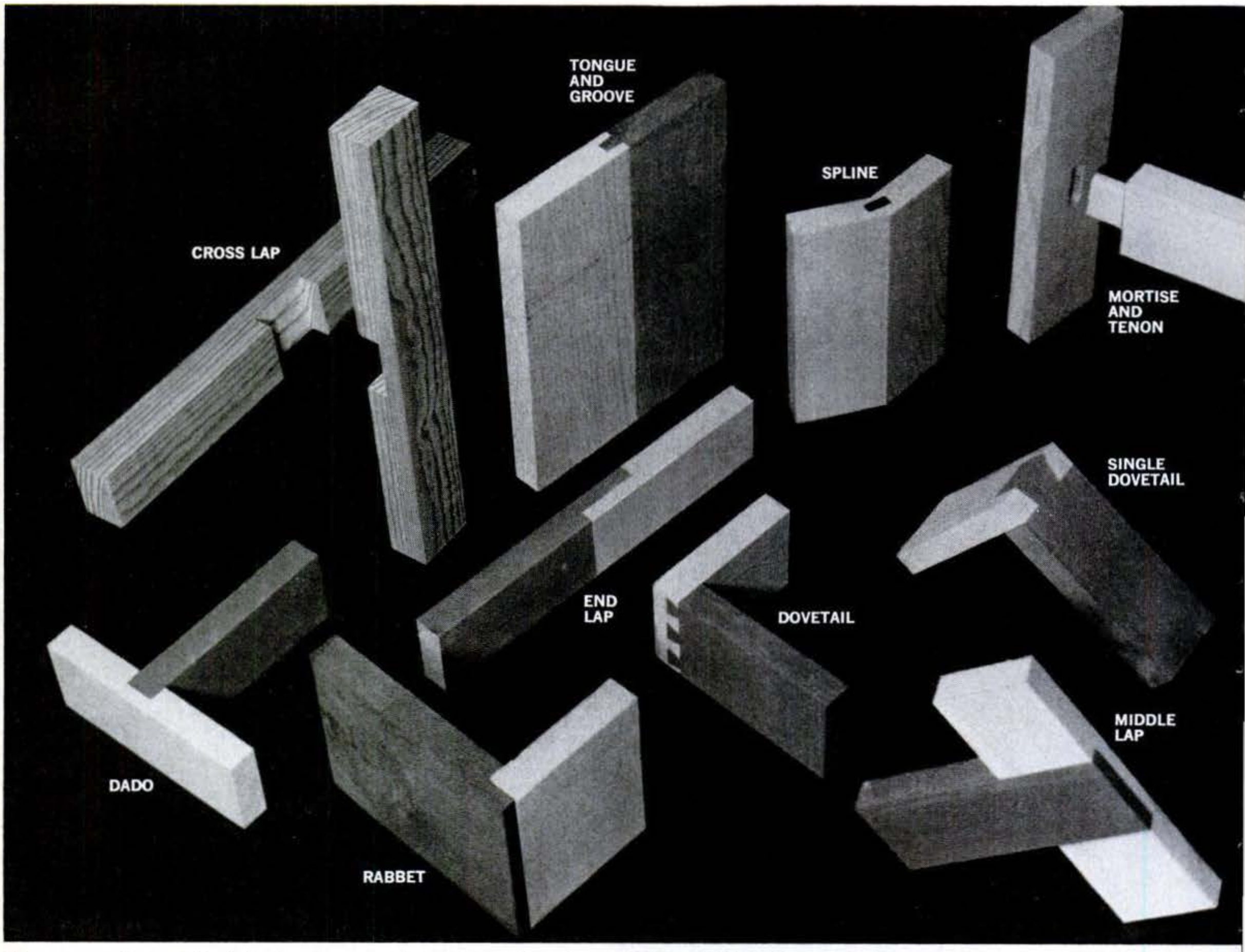
The list goes on and on. Of course, a router can't do all this work itself. It has to be teamed up with bits and accessories. For the most part, however, the additions you'll need for specialized jobs are inexpensive or even simple to build yourself.

In these pages, you'll see routers at work with a variety of bits and attachments. For the ambitious craftsman there's a page of simple jigs you can make to help a router perform all sorts of work in the woodshop. And, in case you haven't bought a router yet, take a look at the shopping hints on page 84. This guide will give you handy info you should know *before* you hit the store. PS

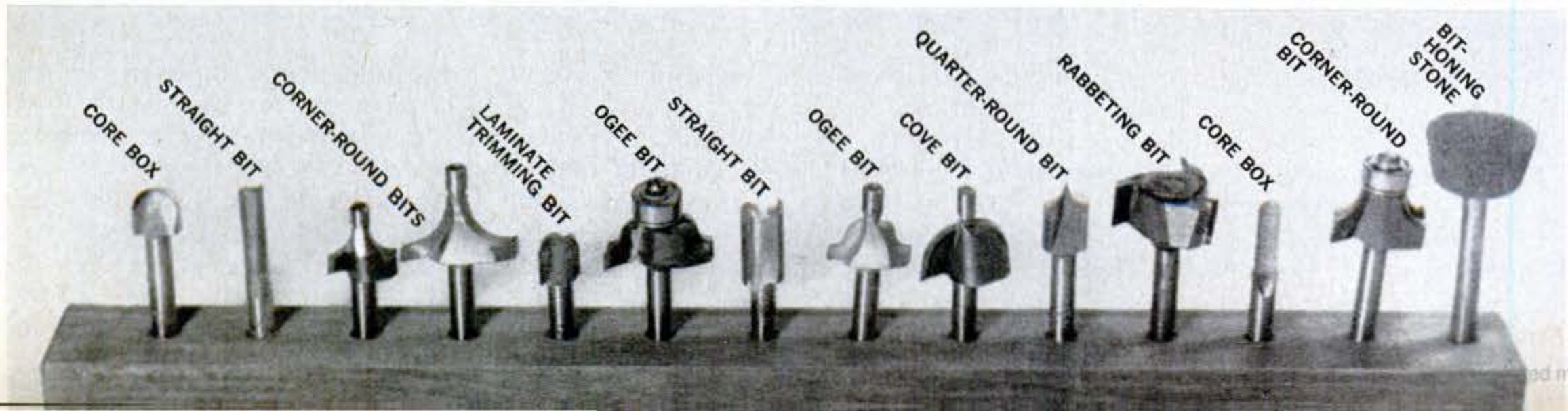
More on routers below and on the next three pages



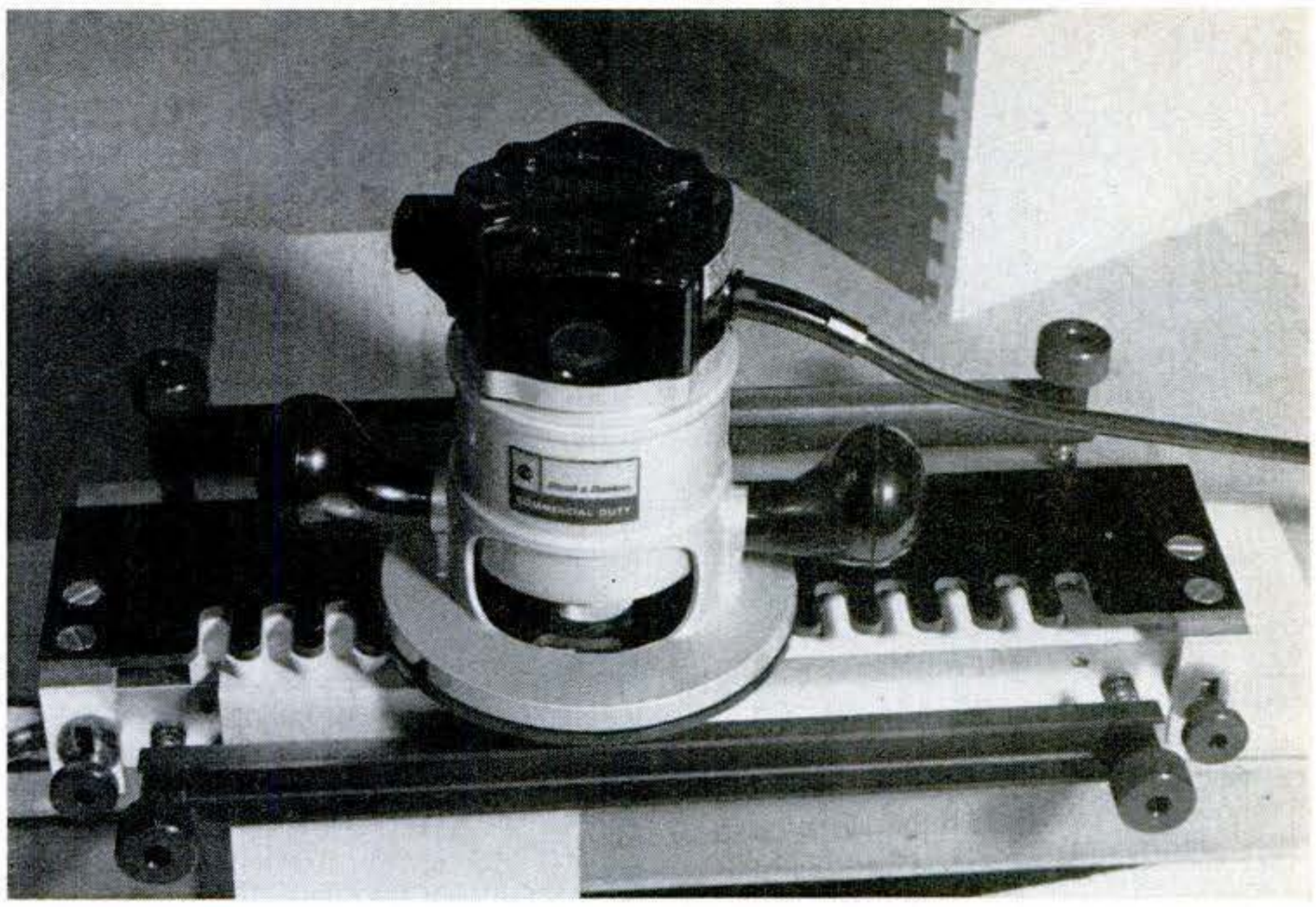
Edge guide is the basic router accessory. It lets you make cuts parallel to the edge of the workpiece. Here it's guiding a dovetail cut, which must be made in a single pass—a job for a powerful router like this Stanley.



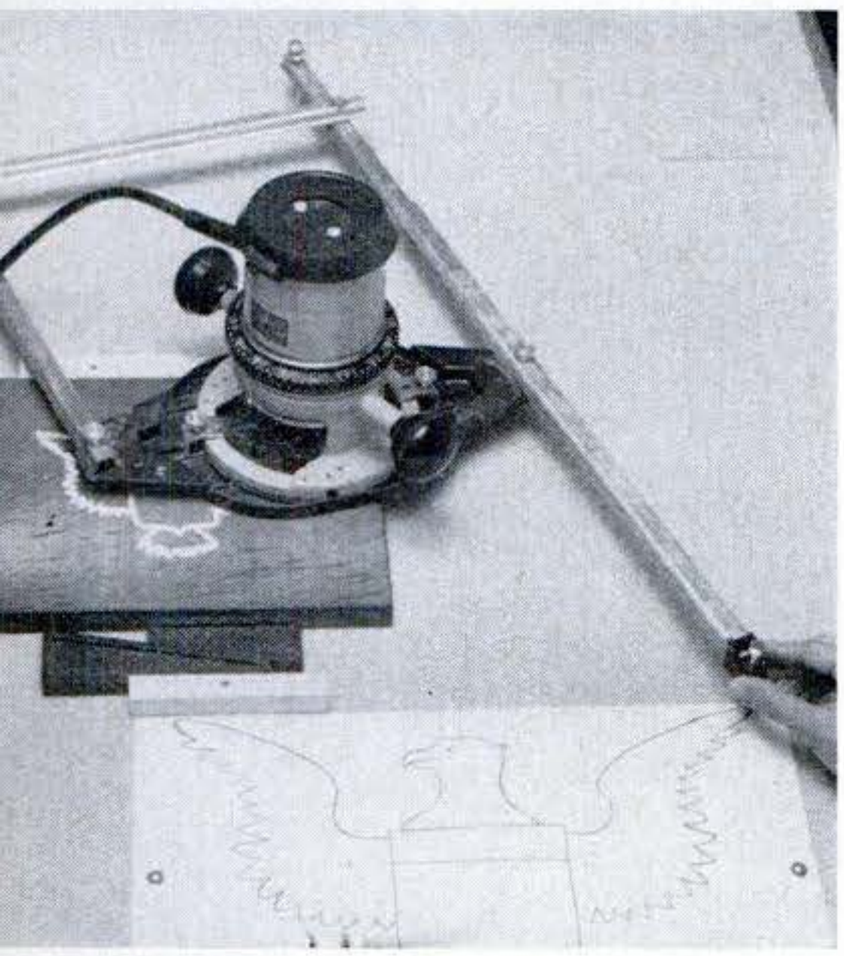
Above are a few of the joints you can make with the bits shown below. All but dovetail joints are made with straight bits.



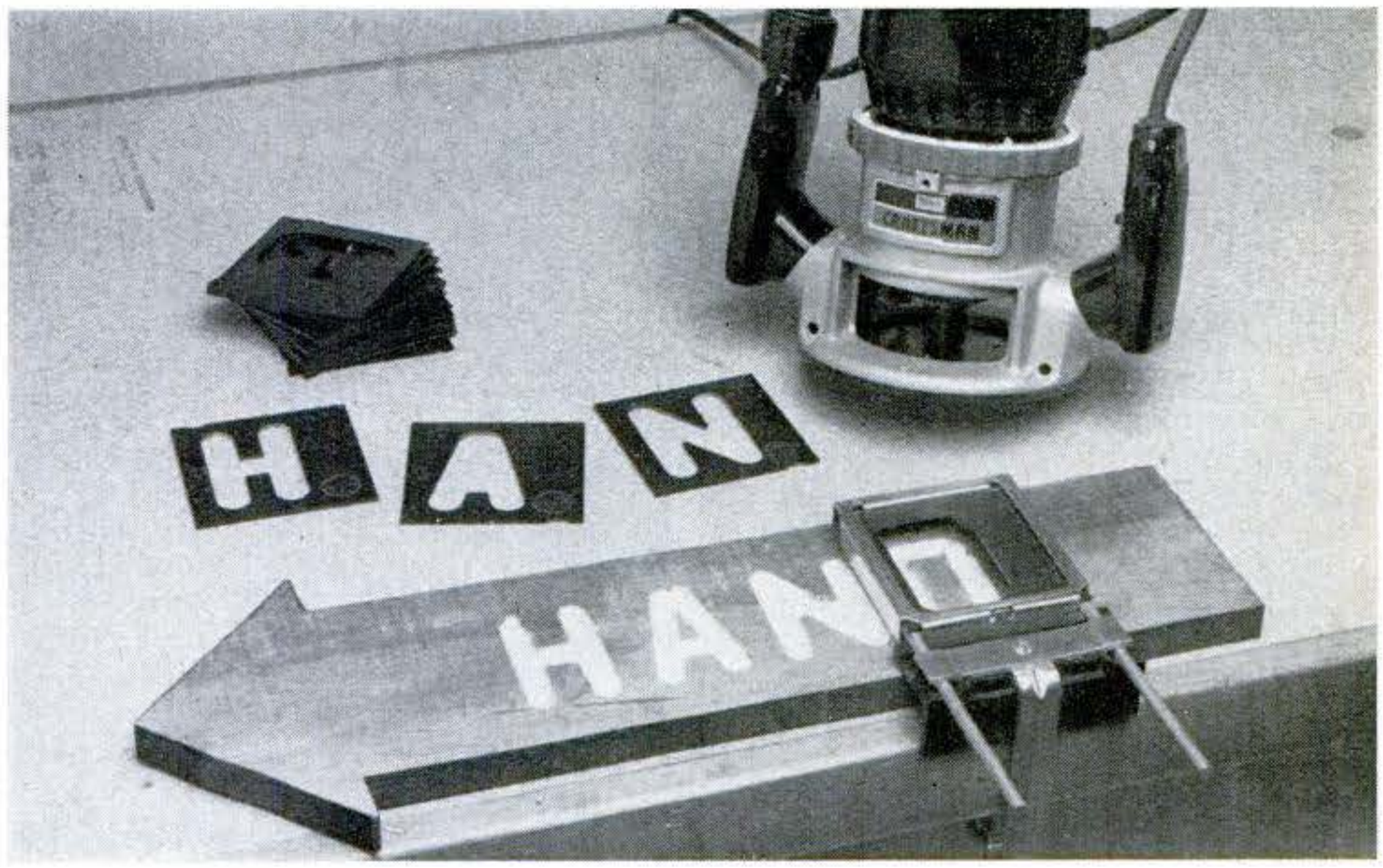
Circle-cutting guide lets you make perfectly round grooves. Or, with the proper bit (a combination panel bit), you can drill right through the stock and cut out a circle, the same as you would with a jigsaw.



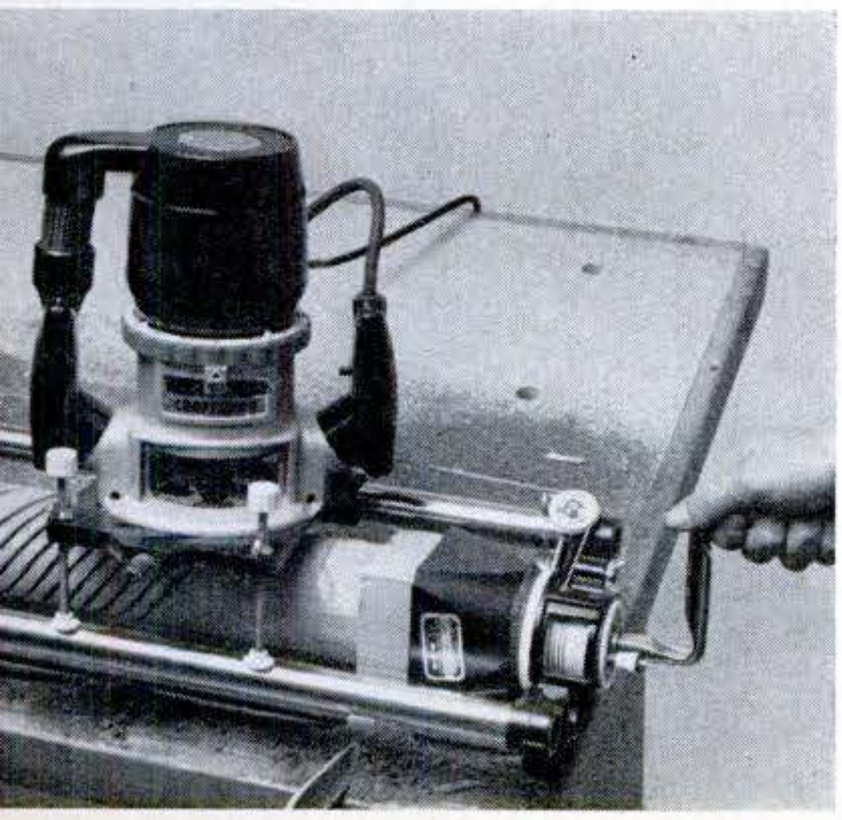
Dovetails—strongest joints possible—are automatic with a dovetail guide. Initial setup is critical, but from then on you can work blindfolded, making cuts on both pieces to be joined simultaneously in a single pass.

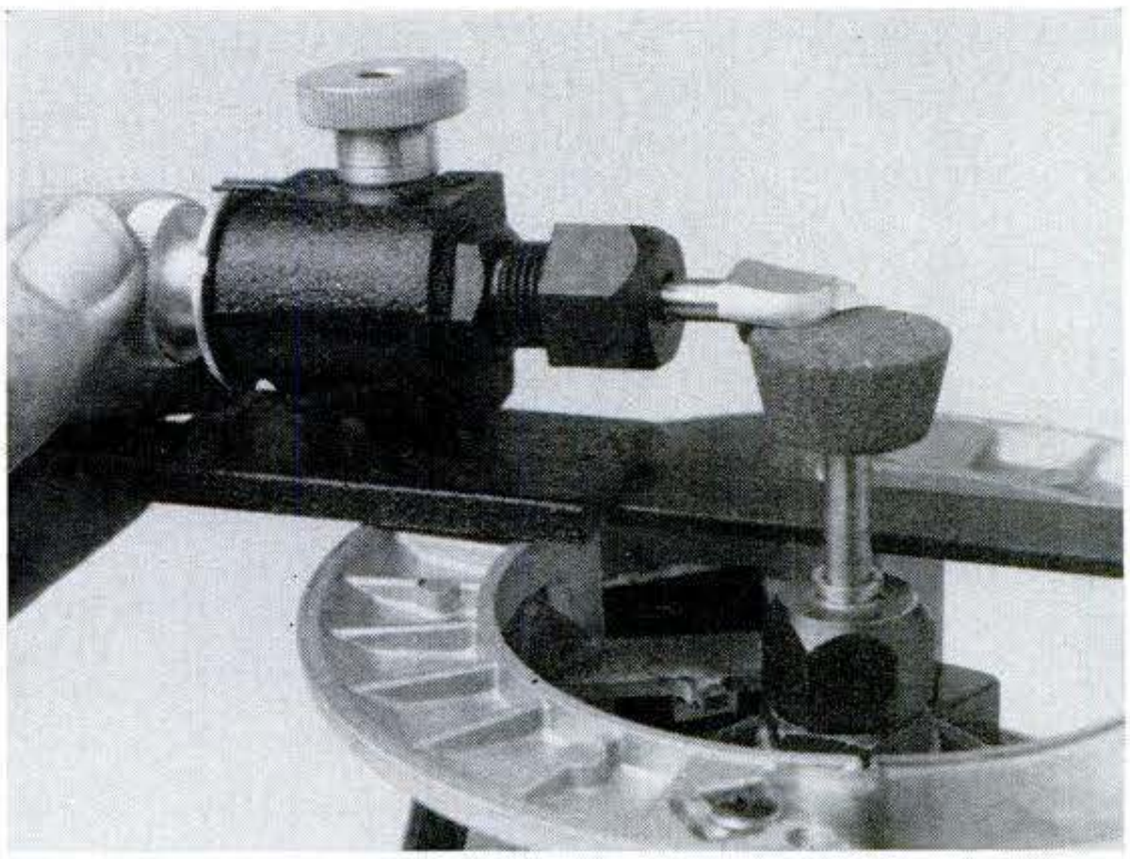


Pantograph makes it easy to copy designs with your router. This one, and others, will work with any router. You get best results with a V-groove bit set to a shallow cut. Eagle here is being reduced 50 percent in size.



Lettering guides come with templates that let you carve signs and plaques. This typical one comes with a set of templates for cutting numbers as well as letters, plus a holder to secure templates to work.





Sears Router-Crafter lets your router do the work of a lathe, plus more. It will make spirals, flutes, tapers, coves, beads, and contour cuts. With a homemade template, it produces identical turnings automatically.

Routers can even sharpen their own bits with special fixtures sold by most makers. To use them, you chuck a special stone in the router, then mount the bit to be honed in the fixture chuck. This rig will handle all but carbide bits.

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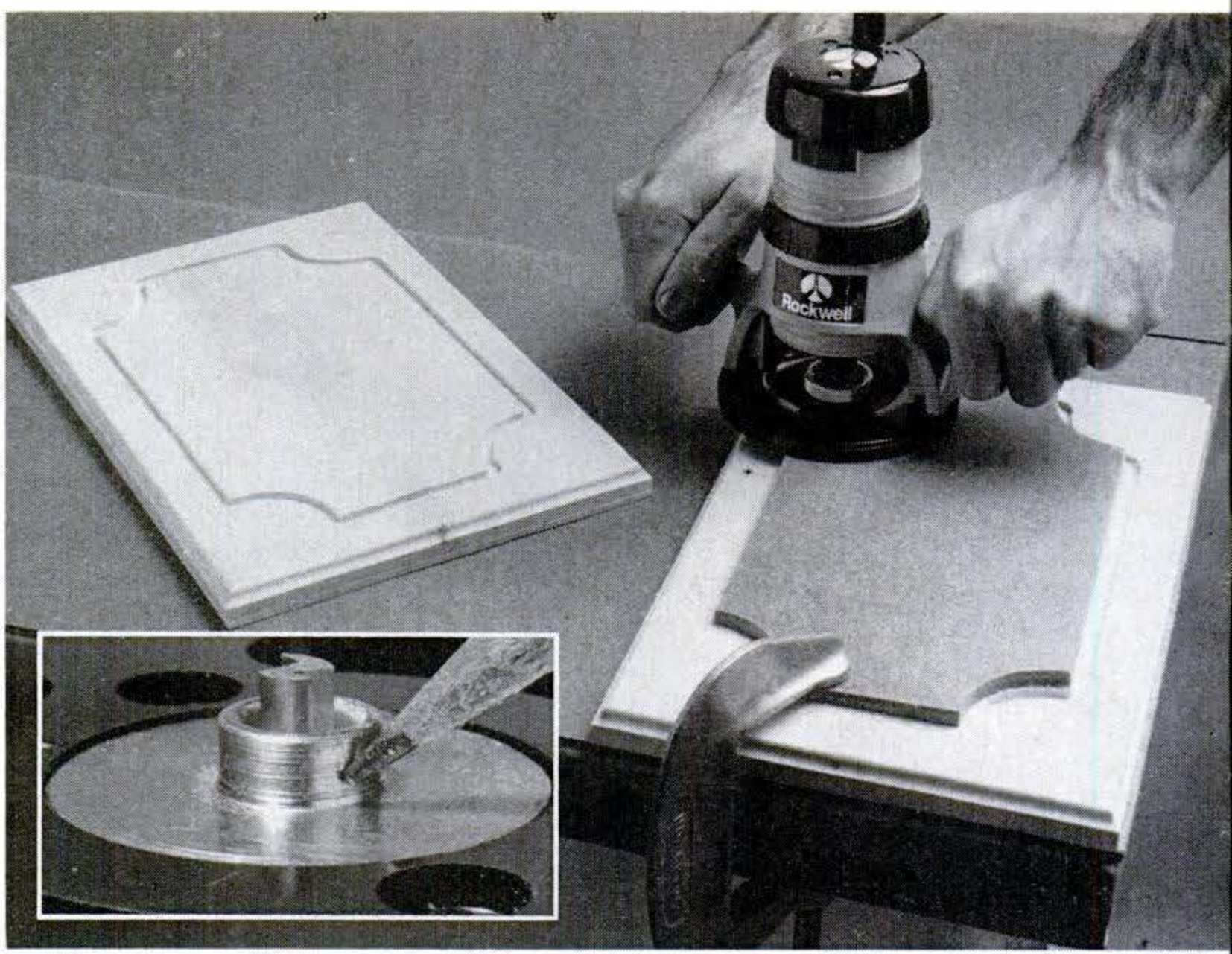
How to pick the right router —light or heavy duty?

The router is a simple tool, little more than a motor with a chuck mounted directly on its shaft, plus a base. The main shopping considerations are power and bearing quality, which tend to go hand in hand.

If you plan to use your router for only occasional light work, half a horse is plenty of power. But if you'll use it a lot, especially for heavy cuts, you'll be happier with up to a full horse, or more.

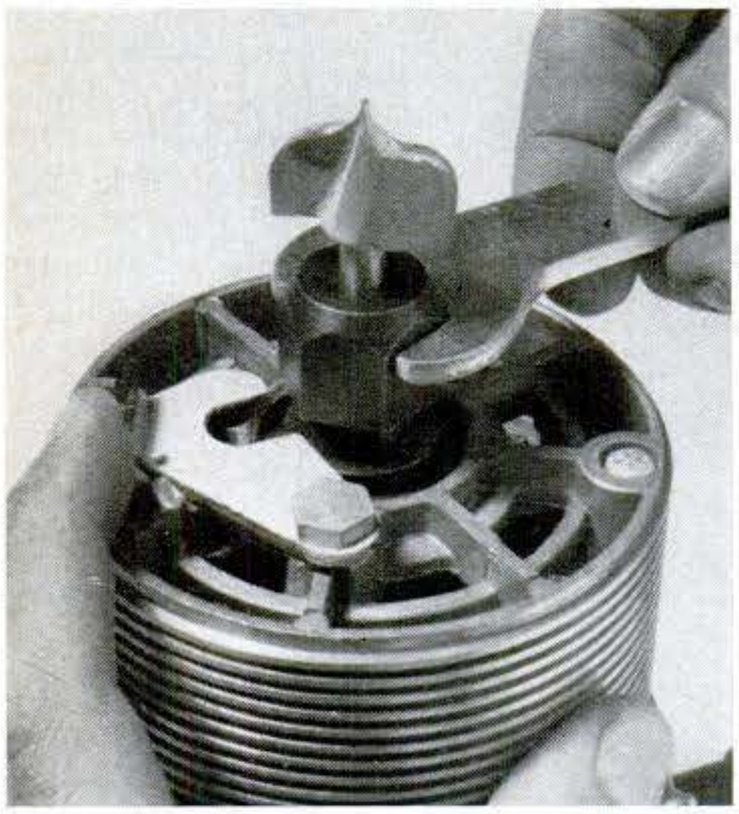
Of course a light machine can do the same work as a heavy-duty model. But you'll have to baby it, making two or three progressively deeper cuts to do what a bigger unit can accomplish in a single pass. Eventually, however, the strain starts to show. My first router was a pint-sized model and it wore out after a year or so of normal shop use. The bearings couldn't take it. For long life, a router should have ball bearings. But these usually don't show up in routers with less than 5/8 hp. The moral: If you buy a light-duty router, use it mainly for light-duty work.

Once you decide on power, look for features that appeal to you. The photos illustrate some things to check for. Just remember you probably can't get everything you want in one router. For example, the Sears router shown here has a trigger switch, one-wrench bit changing, and an optional dust-collecting kit, all good ideas. But you can't remove the motor from the base, and that's a limitation at times. Your router will probably be a blending of features you want with some you may not like.



Templates make it easy to produce perfect cuts for jobs like this cabinet-door design. Make your own template out of hardboard. Mount a template bushing on router base; the bushing (inset) follows template contours.

Veneer-and laminate-trimming bits with ball-bearing pilots take interchangeable carbide cutters that produce perfect flush cuts, or bevels in a variety of angles for corner cuts. You remove nut at tip of bit to change cutters.



Bit changing is easier if your router has a built-in shaft lock. Without it you need two wrenches instead of one to change bits—one to hold the motor shaft, the other to turn the collet nut. The router shown here is made by Skil.

Dust-bag attachment sucks chips up through router handle and deposits them in a cloth bag on this $120 Sears router. The rig works best on center cuts. On edge cuts many chips just drop away from the router base.

Depth adjustments are usually threaded collar (right) or rack-and-pinion (left). Rack-and-pinion is best for shaper table use. When suspended upside down under shaper table, collar-type's motor will fall out during adjustments.

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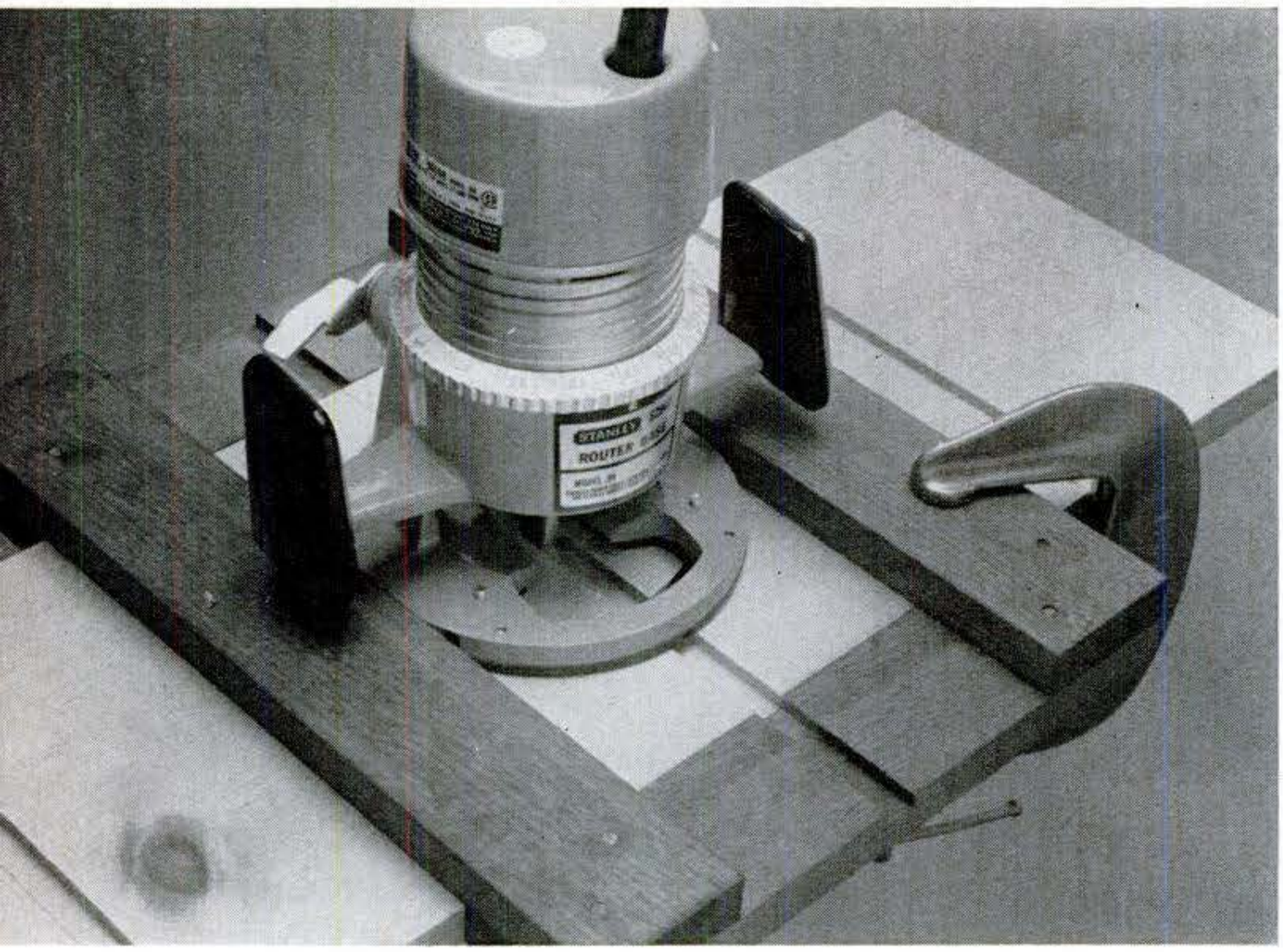
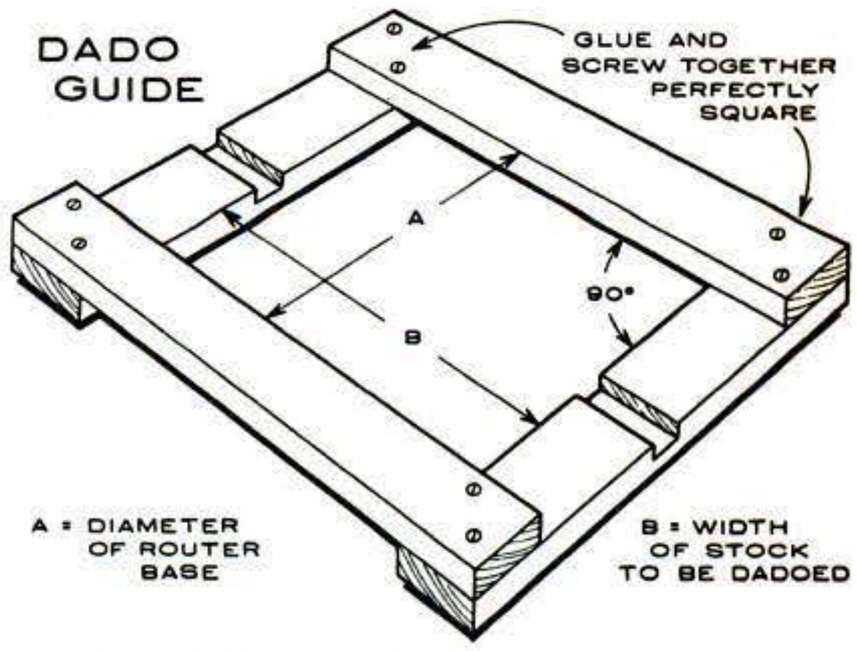
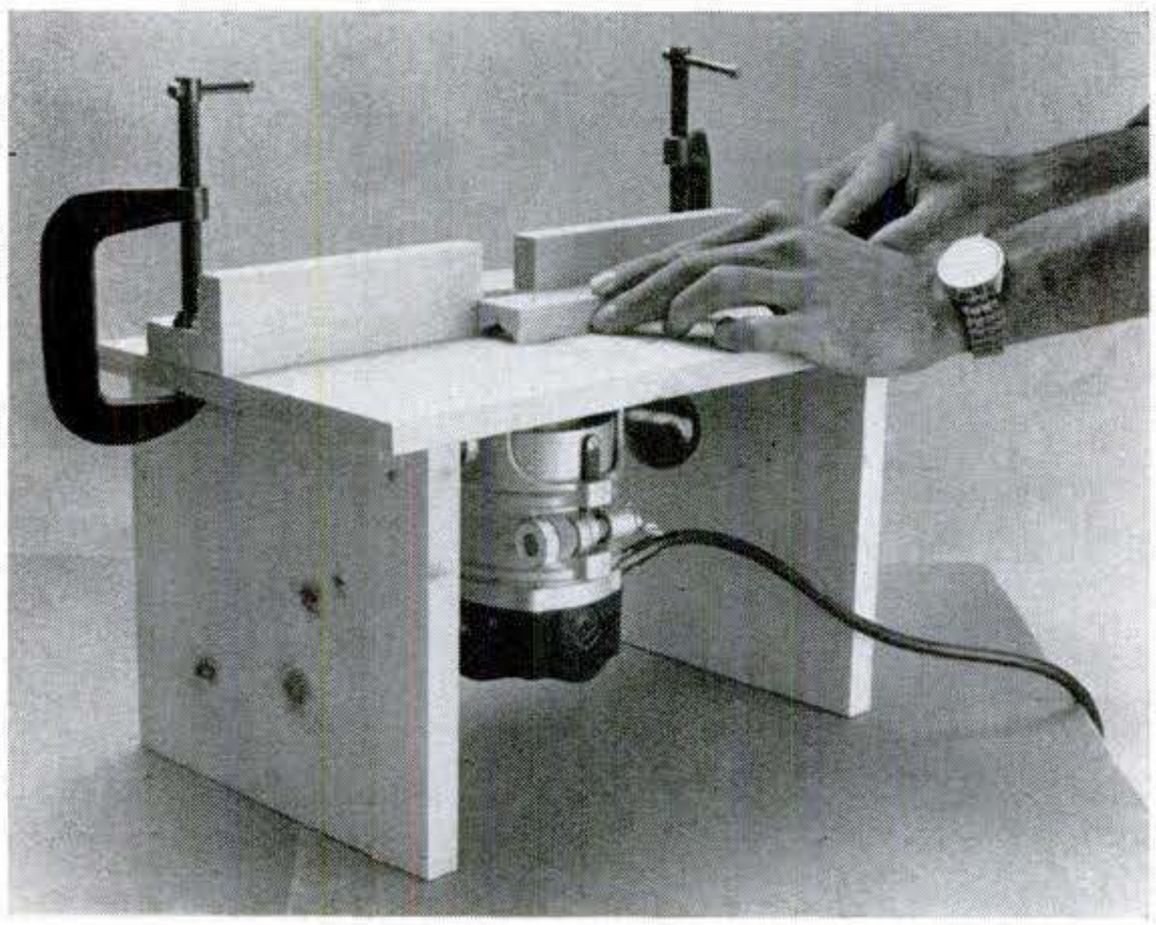
Three simple jigs you can make

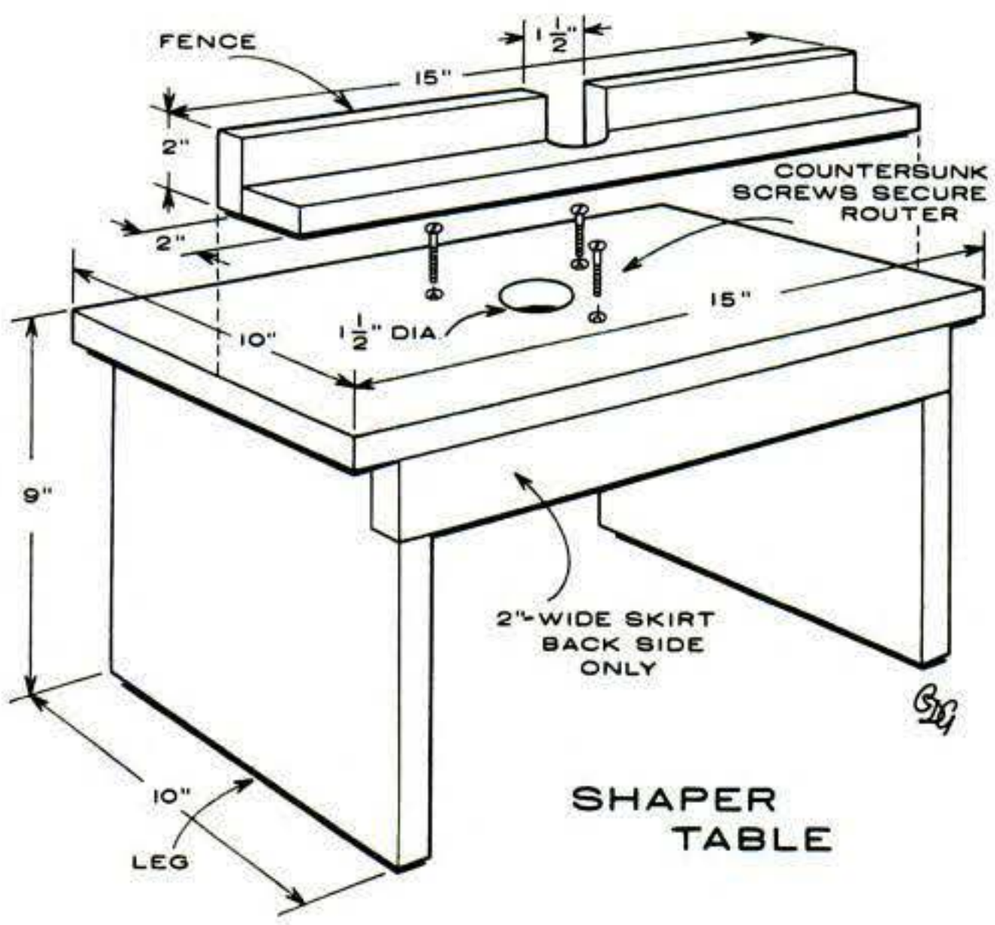


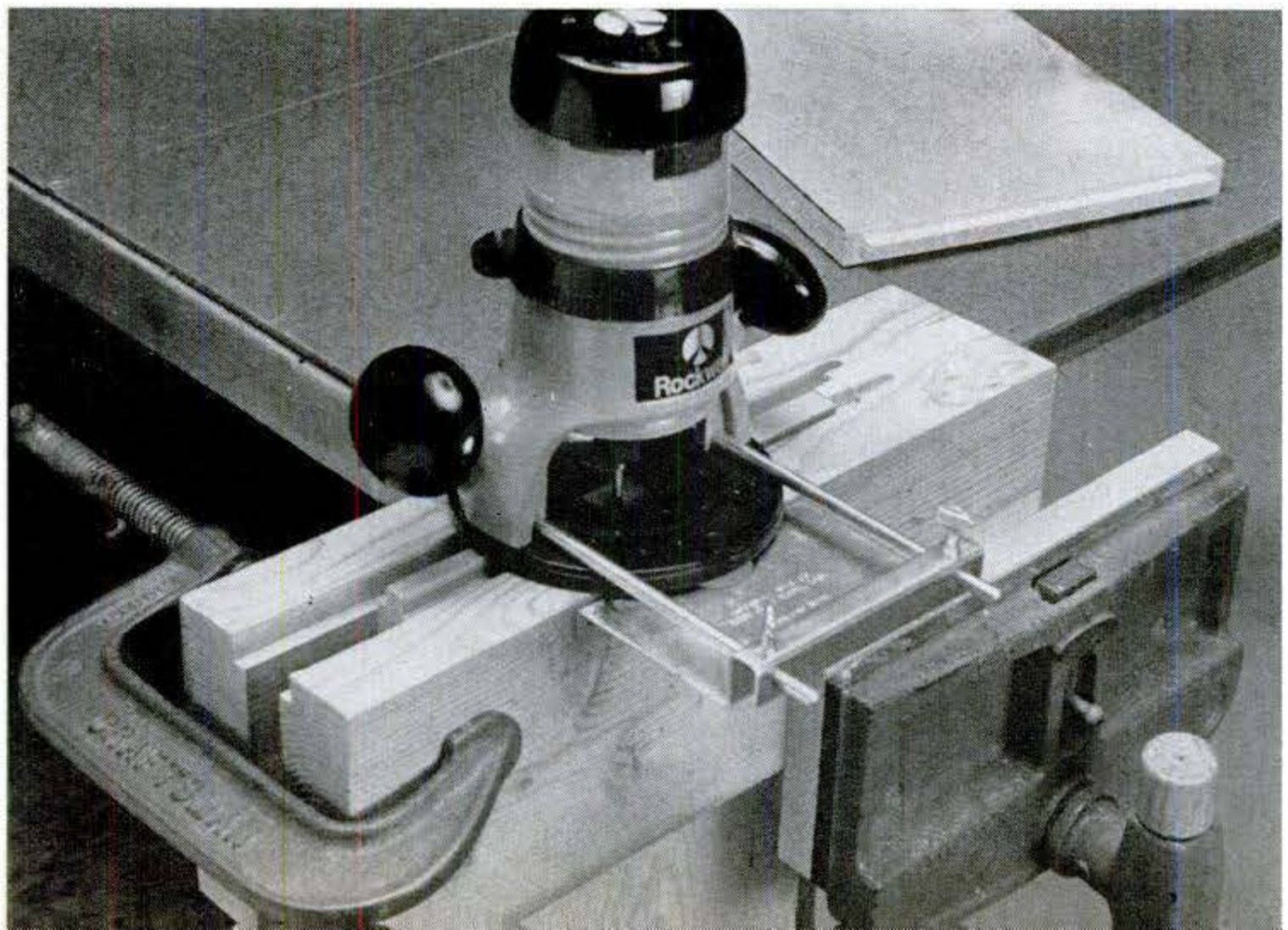


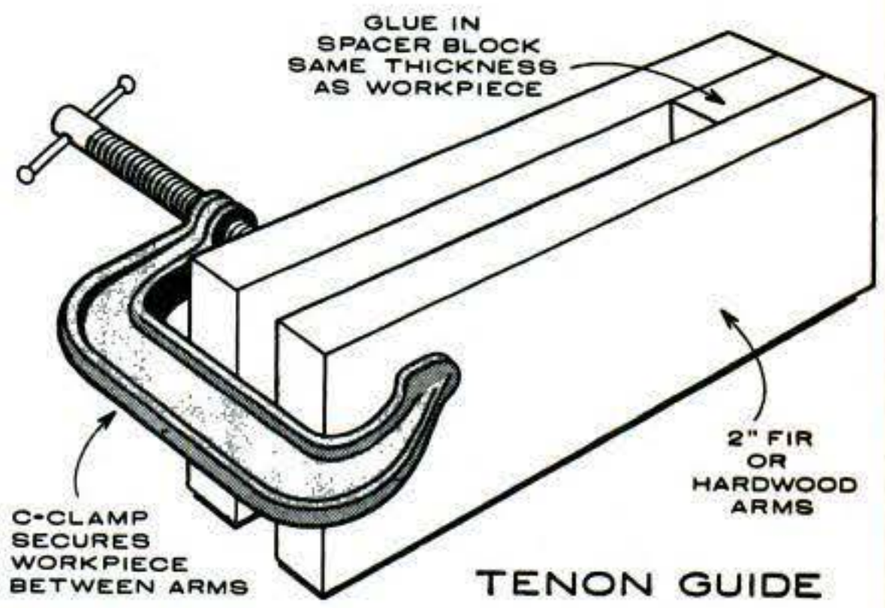
Cutting dadoes is fast and easy with this box-type guide. If workpiece isn't warped, you can hold guide with one hand, run router with the other. If work is warped, clamps will secure guide and pull work back into true flat shape.

Simple table holds inverted router and gives you a shaper that's handy for working small pieces and making moldings. Flat-topped router with side power cord and rack-and-pinion depth adjustment works best in this application.









Guide for cutting tenons in the end of narrow stock povides extra stability for router. To use, mount guide in vise, slide work into guide, flush with top, and secure with C-clamp. Mount edge guide on router and make cuts.

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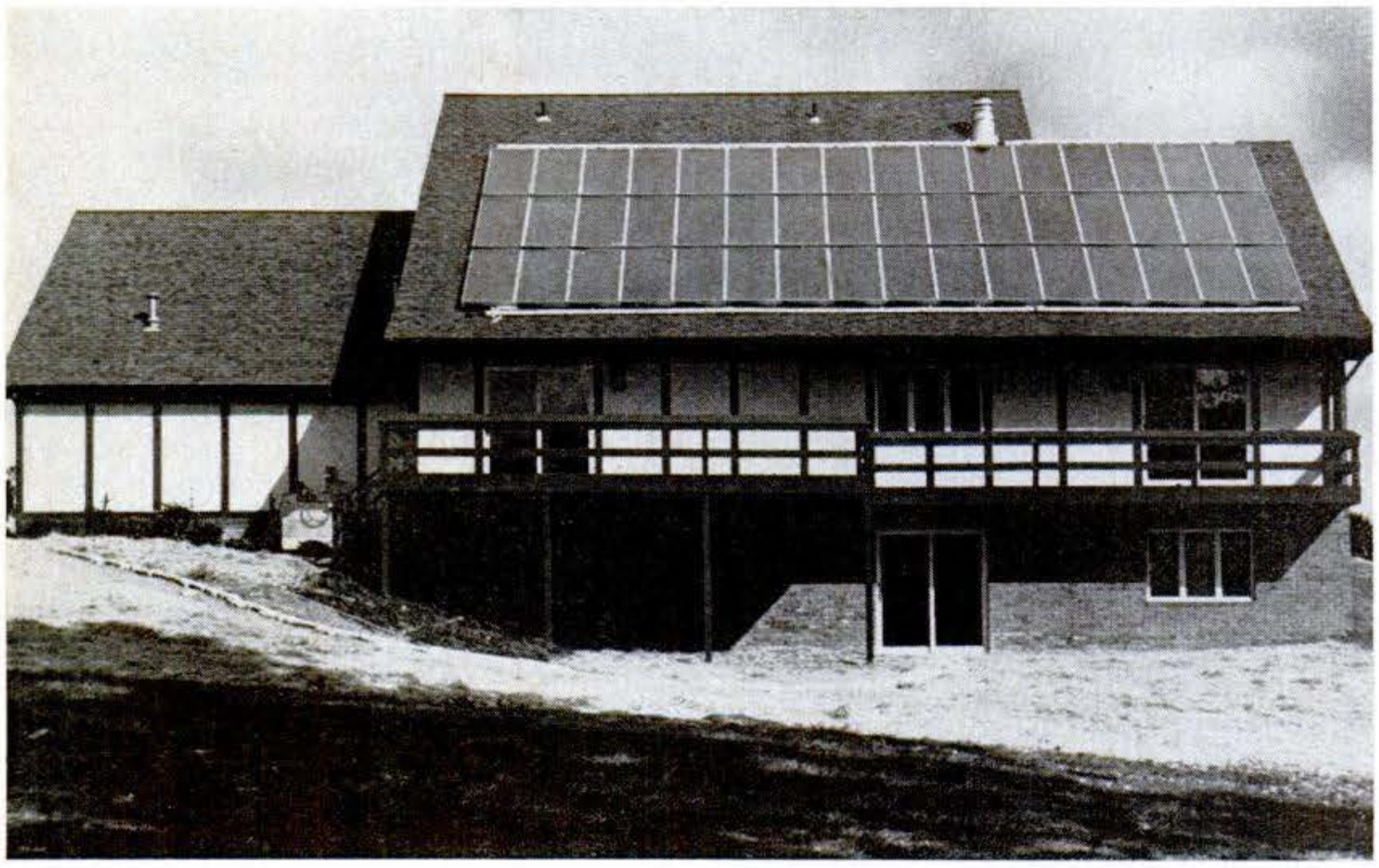
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS



Solar cooler/heater

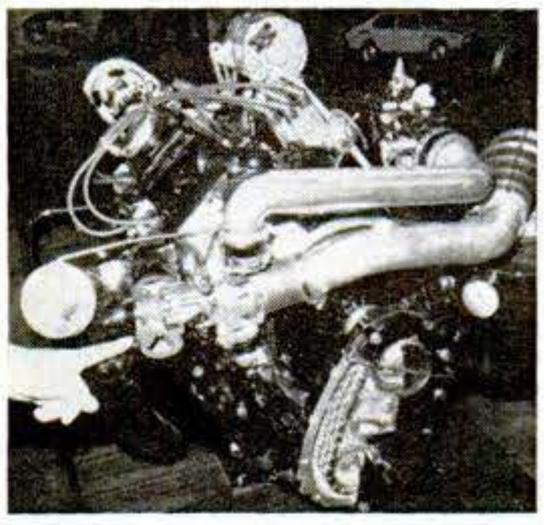
Those 48 flat-plate solar panels help supply 75 percent of the heating and cooling needs in Arkla Industries' demonstration home in Evansville, Ind. Heated water energizes an absorption chiller for up to three tons of air conditioning, or passes over coils to heat the air.

Tube seats

More passengers in less space—that's the idea behind these strange-looking seats. Made with welded steel tubes and PVC-coated foam, they require 35 percent less space than regular bus or train seats, according to Italian designers Clara Nardone and Paolo Bernacca.

Floating hose

Oil spills from offshore rigs are less likely with Saflote floating hose. An inner high-pressure hose fills nearby tankers. A buoyant outer hose, made with layers of unicellular expanded rubber, contains the oil if a rupture develops. It's made by Dunlop in Great Britain.



Saab turbo

Need extra power for passing or fast getaways? Jab the Saab Turbo's accelerator and you'll tap reserve power from the turbocharged 121-cubic-inch engine. The Swedish four-cylinder engine has a small exhaust-driven blower (left) to boost power at normal driving speeds.

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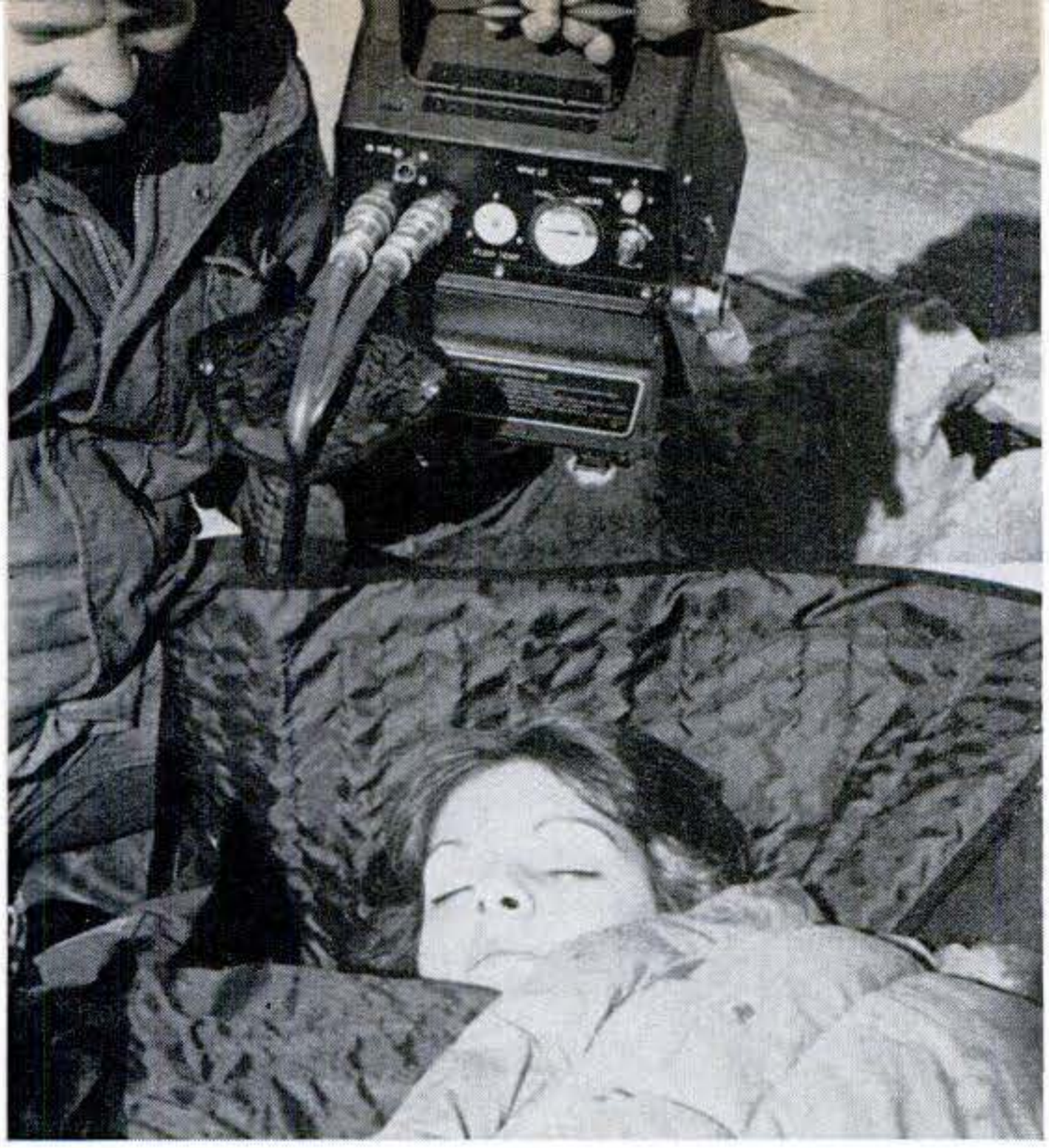
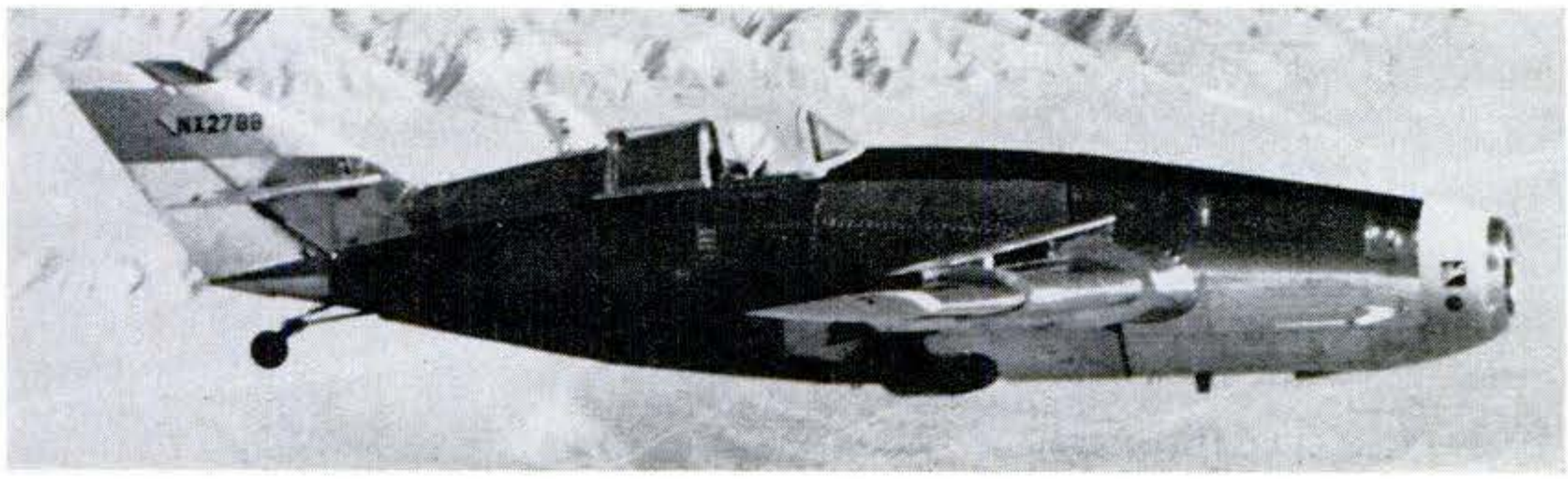


Life saver

Victims of hypothermia—a deadly drop in inner body temperature from exposure—may be revivable with a Warm-Rite. The 18-pound unit heats and circulates a liquid through tubes in an insulated bag. $1551 from Energy Systems Corp., One Pine St., Nashua, N.H. 03060.

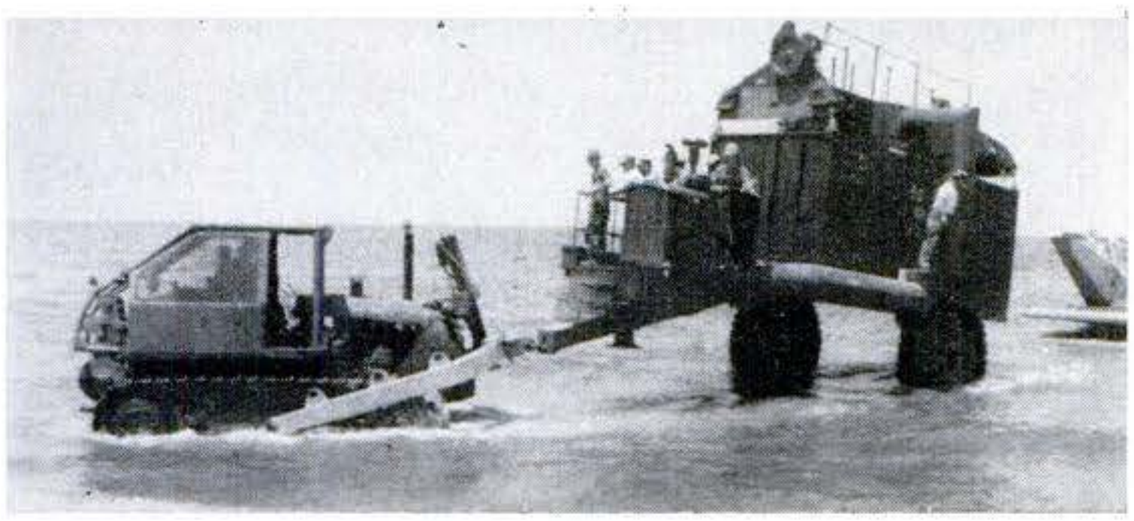
Chill meter

Here's a warning when low temperatures and high winds can freeze your skin. The Wind Chill Meter offers two readings, one for air temperature, one for chill factor. It's $10.95 from Edmund Scientific, 7782 Edscorp Bldg., Barrington, N.J. 08007.



Jet wing

It's a jet-powered plane, but where's the exhaust? The Jet Wing is powered by a turbofan engine, but bypass fan air and hot exhaust gases are directed from the fuselage and over the wings for propulsion and extra wing lift. Ball-Bartoe Aircraft is developing the plane.



Cargo lander

An eight-by-eight-by-20-ft. cargo container from a landing craft is towed ashore in a Lightweight Amphibious Container Handler (LACH). LACH is under Navy development for Marine use. The Navy claims it's the most efficient system yet devised for unloading containers.

Chevy LUV

There's more cargo space and leg room in the Chevrolet Series 8 LUV truck for '78. The new $3845 model has a 90.1-inch pickup box that supports a 1635-pound load, plus a longer (118 inches) wheelbase. A four-cylinder 80-hp engine provides 27 mpg (EPA).

Lifetime 10-speed

Younger riders can adjust this 10-speed bike to grow with them. Ross' model 11-354 Compact features adult-size 26-inch wheel, a specially designed 17½-inch frame, and an extra-long 10-inch seat post. A dual-stem shifter and side-pull caliper brakes are standard.

Water barrel

Transporting fresh water to your trailer or boat is easy with the Waterball. The three-part, 16-gallon plastic drum comes apart for compact storage. End bowls can serve as wash basins. H. Burden Ltd., Pytchley Lodge Rd., Industrial Estate, Kettering, Northants, England.

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What's New IN PHOTOGRAPHY

By E. H. ORTNER

110: Small flasher

Smallest, lightest 110 pocket camera with built-in electronic flash—that's Fuji's claim for the Fujica 350 Flash. The flash pops up when the light's too dim for normal shooting. The 350 has a fixed-focus 20mm f/5.6 lens, weighs 6.3 oz., and lists for $79.50.

110: Close looker

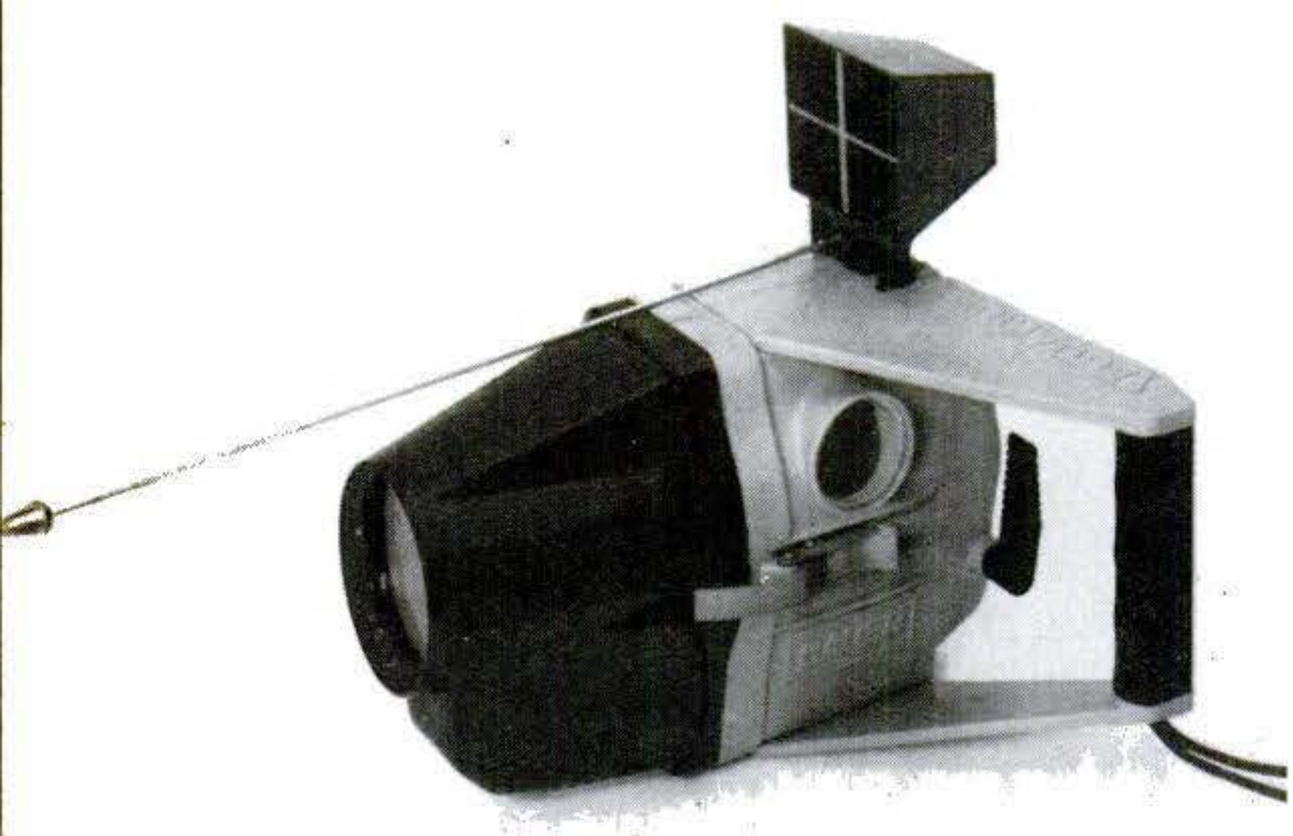
A built-in close-up lens lets you get within 19 in. of your subject with Minolta Autopak 110 camera. The 6.3-oz. camera offers programmed automatic exposure with shutter speeds from two sec. to 1/1000 and a focusing 26mm f/3.5 lens. List price: $100. The clip-on flash is $20.

110: Closest looker

The built-in lens on the Agfamatic 5008 Makro lets you get within 10 in. of your subject. The automatic-exposure system offers shutter speeds from 15 sec. to 1/1000 (with red and green LED indicator signals) and a focusing 26mm f/2.7 lens. Price: $159.95.

Rock-ribbed tray

Touch a finger to the rim of the Wave Tray, and it rocks gently on its ribbed bottom, swishing photo chemicals evenly over your print. A capped neck at one end permits easy draining—and reclaiming—of chemicals. $4.95. Maker: Ambico, 10 Horton Ave., Lynbrook, N.Y.



Super 8 diver

Stability and balance underwater are features of the Aquarius housing for Bauer super 8 cameras. It offers a cross-hair viewfinder, a close-up rod for maintaining desired lens-to-subject distance, and a claimed depth capability to 165 ft. The housing lists for $225.90.

Hikers' hitch

Backpackers, hikers, and boatmen can keep their hands free with the new wide-strap Kuban Hitch II while their camera is secure, ready for use, and—with weight distributed on the shoulders—easy to carry. It's $14.50. Kurt Mfg. Co., 5280 Main St. N.E., Minneapolis, Minn. 55421.

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What's New IN BOATING

BY SUSAN RENNER-SMITH

Speedy sculler

Bored by jogging? Sculling with the Oarmaster's sliding seat exercises legs as well as arms. The portable rowing assembly ($205) fits the Appledore Pod ($685). This fiberglass sculler also comes rigged for sailing ($1450). Martin Marine, Box 251, Kittery Pt., Me. 03905.

Supple suit

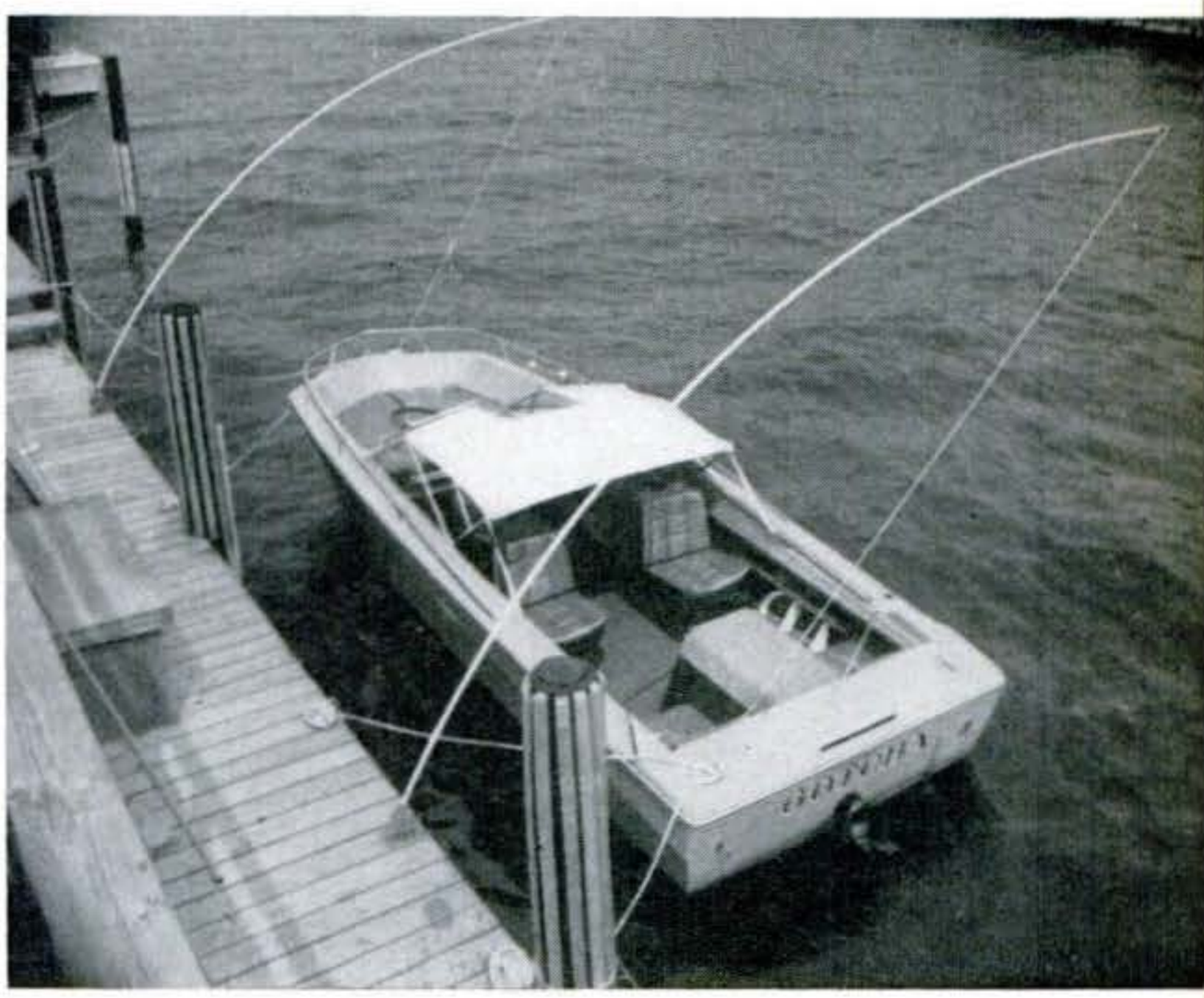
Rain gear doesn't have to be stiff and bulky. The flexible Soft-Suit, made of a new polymer-coated nylon knit, lets you move about freely, says Royal Red Ball (8530 Page Ave., St. Louis, Mo.). The jacket has a visored hood and snap-closed pockets. In green or yellow, it's $80.

Backpack dinghy

Made of Kevlar 29, the Ultra-Lite Breeze weighs only 20 pounds and, deflated, folds into a backpack. The four-person craft has both extra rigidity and directional stability, says the maker: Maravia Corp., 857 Thornton St., San Leandro, Calif. 94577. Price: $900.

Wet boot

Tiny suction cups on the Windsurf's sole grip slippery surfboards, says Adidas. The boot's nylon-net upper, specially cut for ankle support, keeps its shape in water. Designed for the rigors of windsurfing, the boot could also be useful when fishing or sailing. Price: $55.



Surf rider

Flying through the surf, the Wetbike handles like a motorcycle, says Arctic Enterprises (Box 635, Thief River Falls, Minn. 56701). But unlike a cycle, the bike shuts off and rights itself if the rider falls. With its 50-hp, water-jet engine the craft can even tow a skier. Price: about $2200.

Boat protectors

Like shock absorbers, these fiberglass poles bear the brunt of a heavy chop to keep your boat clear of the dock. The Moor Whips come with adjustable, corrosion-resistant alloy mounting bases. Price: $215 to $295. Monarch Tool Co., 66 Clinton Rd., Fairfield, N.J. 07006.

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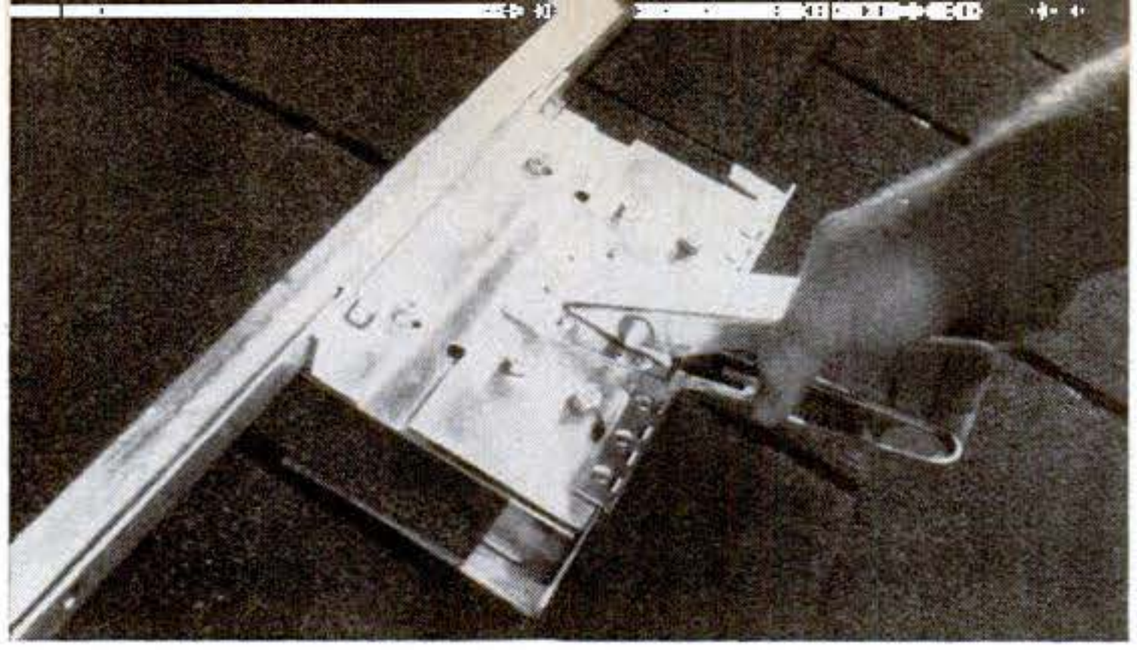
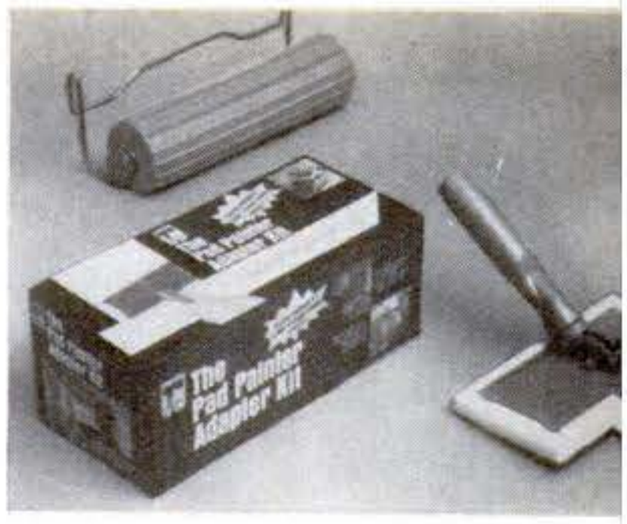
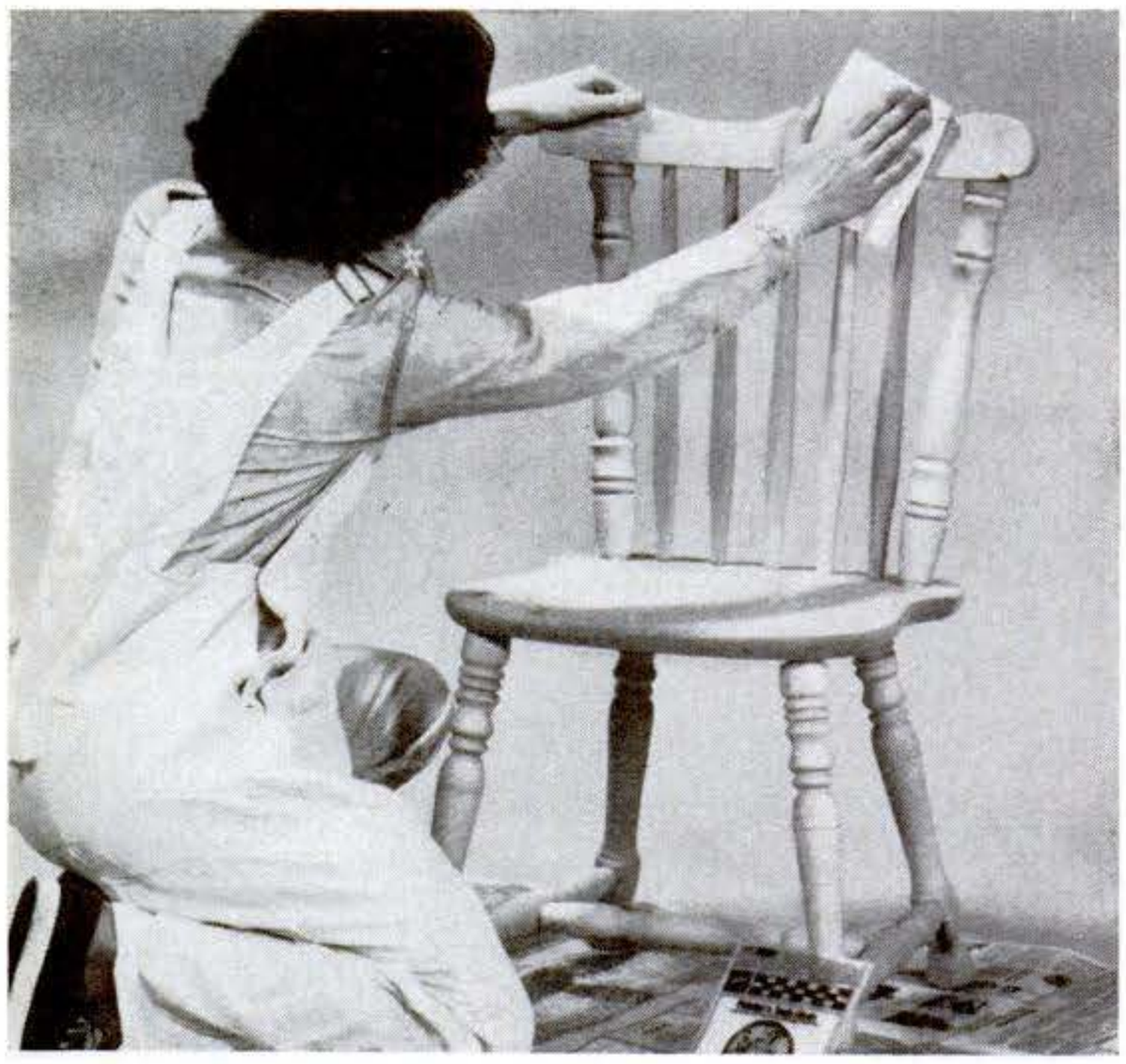
What's New IN TOOLS

BY R. L. STEPLER





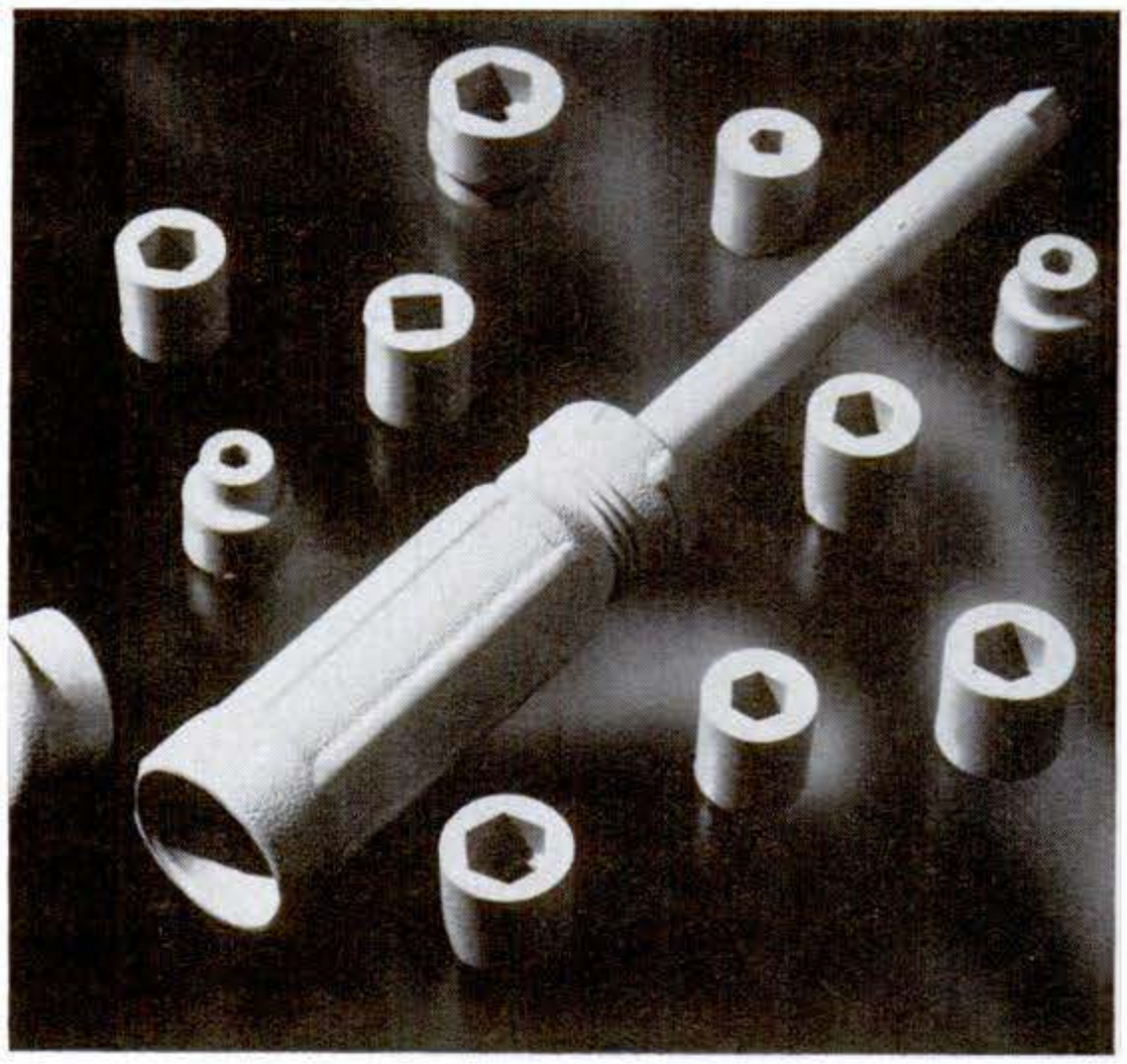


Reshingler

The maker of Shingig says the simple alignment device cuts reroofing time in half—even for do-it-yourselfers. You can rent the tool at home-improvement centers or where roofing materials are sold. Maker: Barnett Mfg. Co., Box 9655, Norfolk, Va. 23505.

Pad painter

The dispensing wheel in Tip Top's pad-painter adapter kit clips into any conventional roller tray to meter the proper amount of paint onto the pad, according to the maker. Price is $6.49. Tip Top Industries, 151 West Side Ave., Jersey City, N.J. 07305.

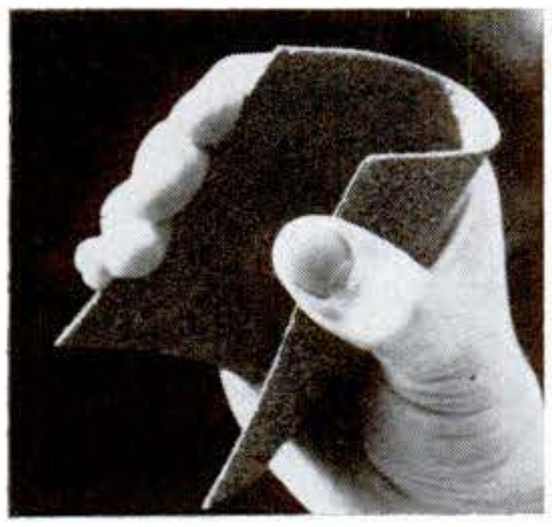


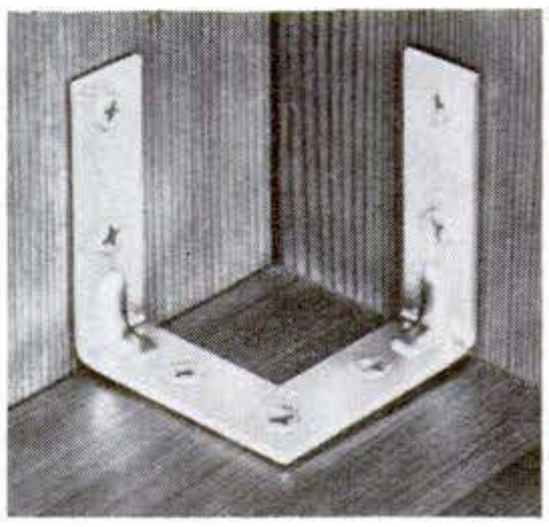
Tack cloth

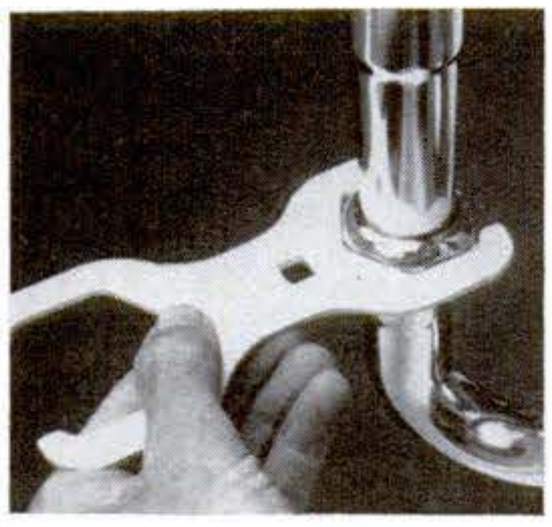
This new 69-cent painter's tack cloth doesn't feel sticky, claims 3M, yet it removes lint, dirt, and sanding dust from metal, fiberglass, wood, plastic, and primed surfaces. From the 3M Co., 3M Center, St. Paul, Minn. 55101.

Socket set

Light weight, high strength, and electric-shock resistance are claimed for this nylon safety socket-wrench set. The set includes a handle and sockets from 1/4" through 1/2". Maker H.O. Canfield Co., Box 149, London, Ohio 43140.







Sanding "squares"

Sanding Squares fit the palm of your hand without a block, says the maker, and conform to the shape of any work surface. The 3 1/2"-by-4 3/8" double-sided pads are made by laminating abrasive sheets back to back. From Evode, 401 Kennedy Blvd., Somerdale, N.J. 08083.

Reinforcer

Stanley's three-surface corner brace reinforces inside joints of cabinets, drawers, tables, benches, chests, and the like. Price for two of the 2" CD998 braces in solid, zinc-plated steel is $1.06. Stanley, Box 1800, New Britain, Conn. 06050.

Drain wrench

Don't have a wrench big enough for this job? Degooser fits most drain-trap nuts, is short to work in tight spots, and can be used with a ratchet wrench for extra leverage. The wrench is $3.59 from Gaspee Sales Co., Box 2175, Providence, R.I. 02905.

Tiny tips

These disposable applicator tips should help you put glue where you want it. Called MikroTips, they fit most standard adhesive tubes. A package of 10 is $1 from Centrix, Inc., 480 Sniffens Lane, Stratford, Conn. 06497.

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What's New IN HOME IMPROVEMENT

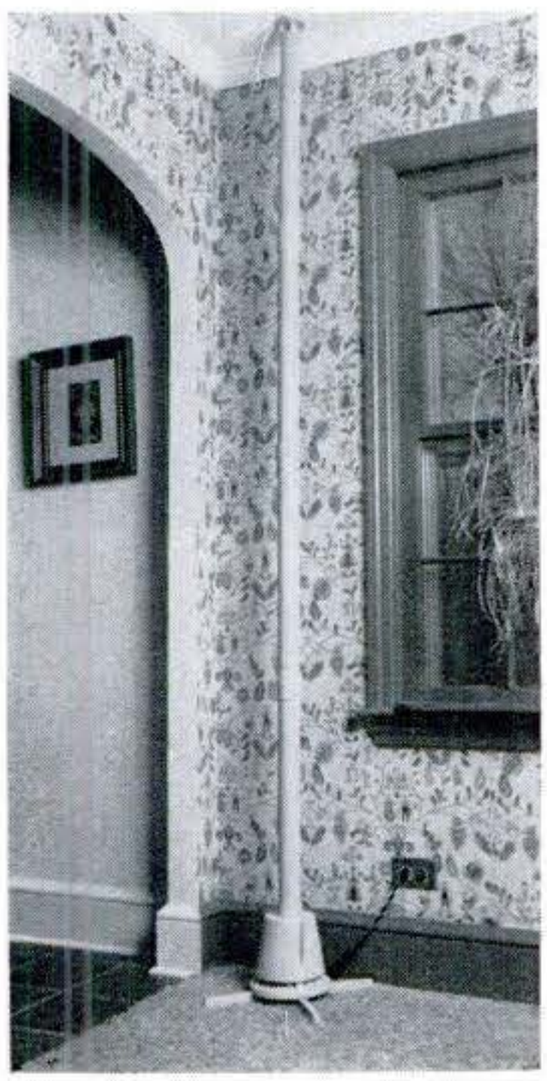
BY R. L. STEPLER

Framing brackets

A greenhouse, potting shed, playhouse, or kennel might be easier to construct with Big-A framing brackets. The polyethylene brackets are designed for use with 1-by-2 lumber. Three 60° brackets: $1.99; four 90°: $2.59. Big-A, 1299 4th St., San Raphael, Calif. 94901.

Adhesive putty

Slipping on skidding rugs? A dab of Fun-tak under each corner should keep 'em in place. Permabond (480 S. Dean St., Englewood, N.J. 07631) says the putty-like adhesive is nonstaining, nontoxic, and retains pliability indefinitely. $1.49 for four 3½" strips.



Destratifier

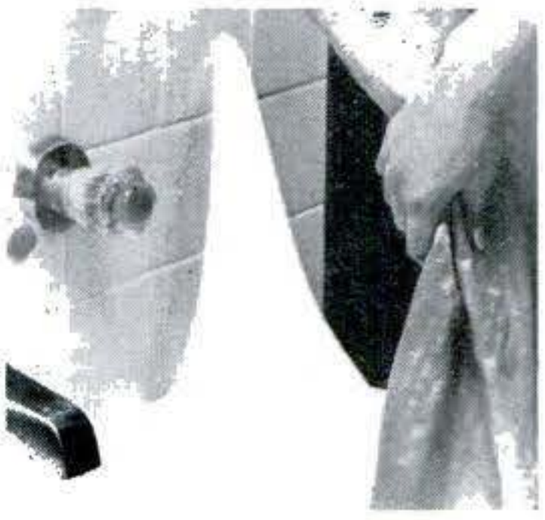
The maker of ThermoCycler says the freestanding device's fan takes in warmer air near the ceiling and exhausts it at floor level to give you more comfort at lower thermostat setting. It's $49.95 from PSI Industries, Box 146, Titusville, N.J. 08560.

Butcherblock floor

The popular natural look is underfoot with Armstrong's Butcherblock design in the company's Stylistik line of flexible, easy-trim vinyl floor tiles. Self-adhering Butcherblock tiles come in two wood tones: medium and light. Armstrong Cork Co., Lancaster, Pa. 17604.

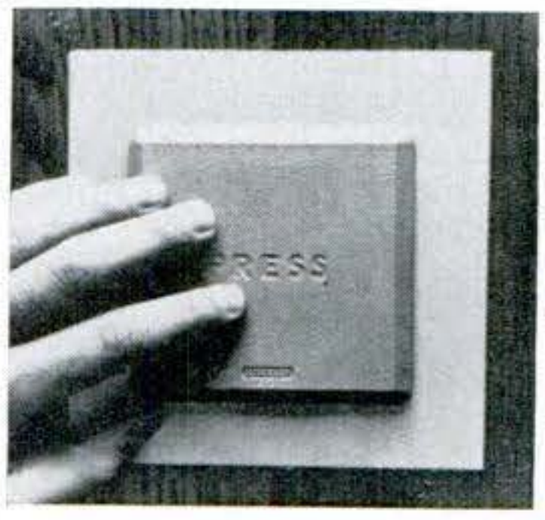
De-flusher

You adjust Dial-A-Flush's dial to reduce the five gallons of water your toilet guzzles with every flush. It replaces flapper or ball-type valves and fits all models with stationary overflow tubes. It's $8.95 from Carlton Industries, 2630 Walnut Ave., Tustin, Calif. 92680.



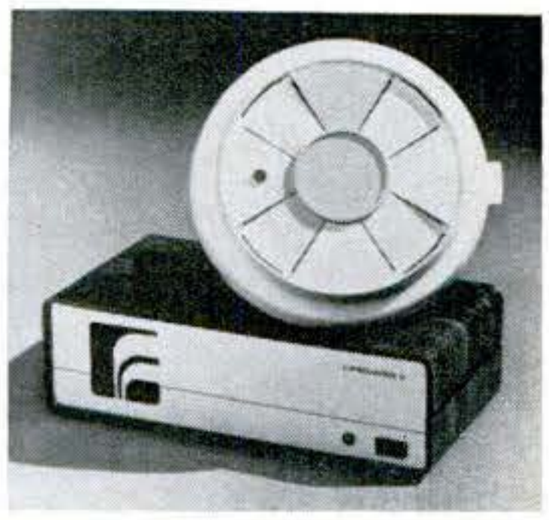
Drip stops

Splash-Enders keep shower water in the tub and off the bathroom floor, according to the maker of the plastic curtain-to-wall gap fillers. Two Splash-Enders and a tube of caulking adhesive are $9.95 from Waterguide, Inc., 8700 SW 26th, Portland, Ore. 97219.



Big switch

At the touch of a hand, elbow, or foot, this 4"-by-4" low-voltage push-plate switch can activate an automatic garage-door opener or a doorbell. The Stanley Works (195 Lake St., New Britain, Conn. 06050) says the vinyl switch's adhesive backing will stick to wood, metal, or concrete.



Smoke detector

The Lifesaver II dual-chamber ionization-type smoke detector transmits the alarm to a remote receiver up to 200 feet away. The battery or AC-powered unit features a test button and an LED power-on indicator. About $100. Fyrnetics, Inc., 920 Davis Rd., Elgin, Ill. 60129.

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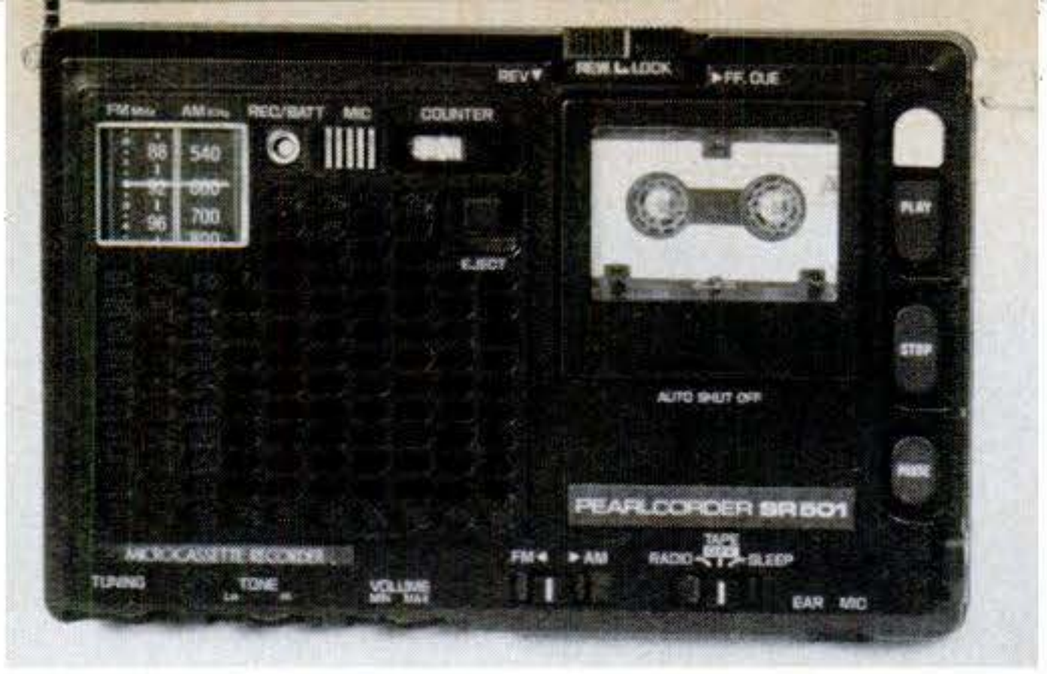
What's New IN ELECTRONICS

BY WILLIAM J. HAWKINS

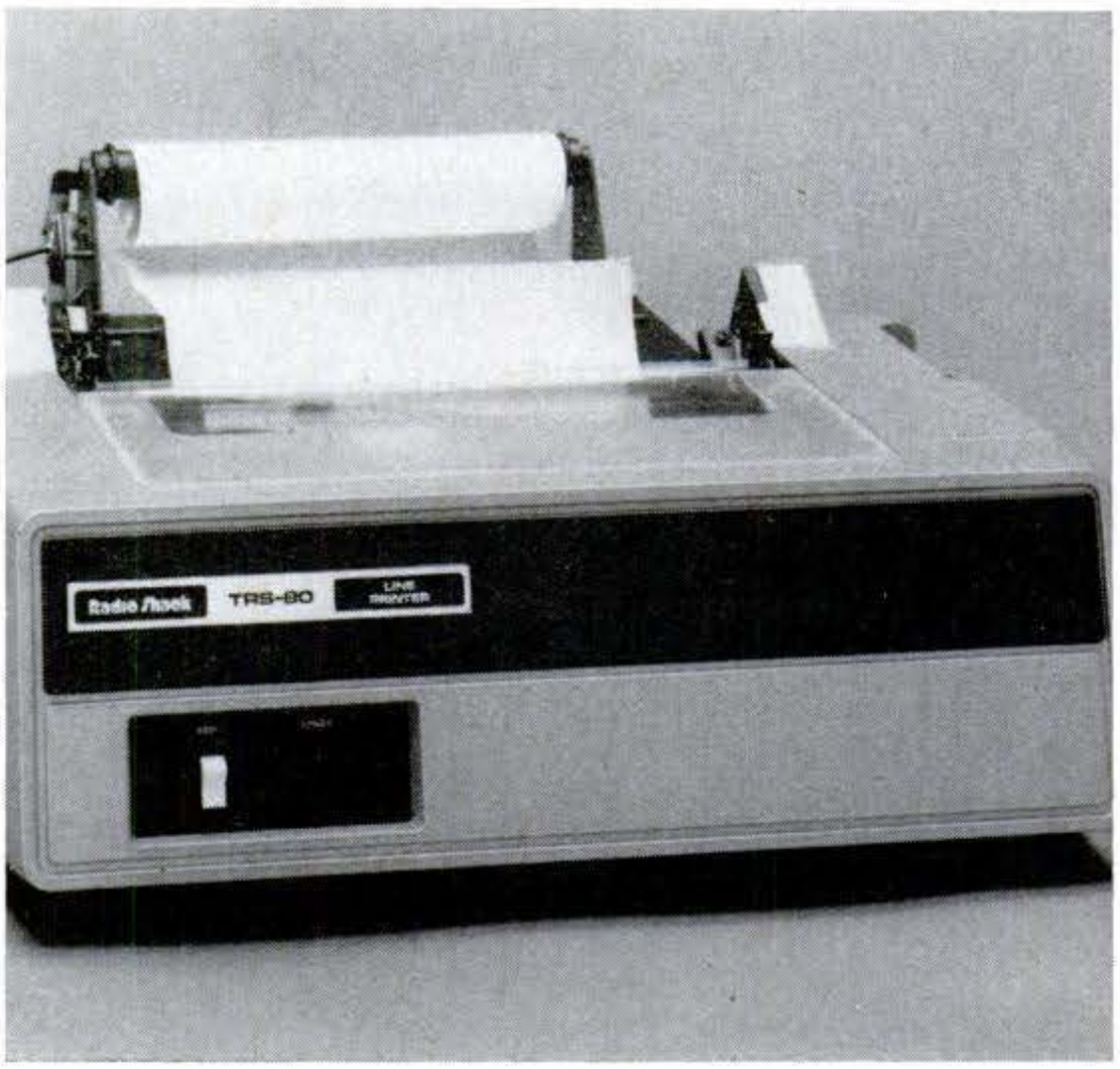


60-minute micro

Pop in a microcassette tape and you get 60 minutes of record or playback time on the new Pearlcorder SR 501 AM/FM tape portable. There's also: built-in mike, 30-minute sleep switch, tape counter, capstan drive. It's $199.95. Olympus, 2 Nevada Dr., New Hyde Park, N.Y.

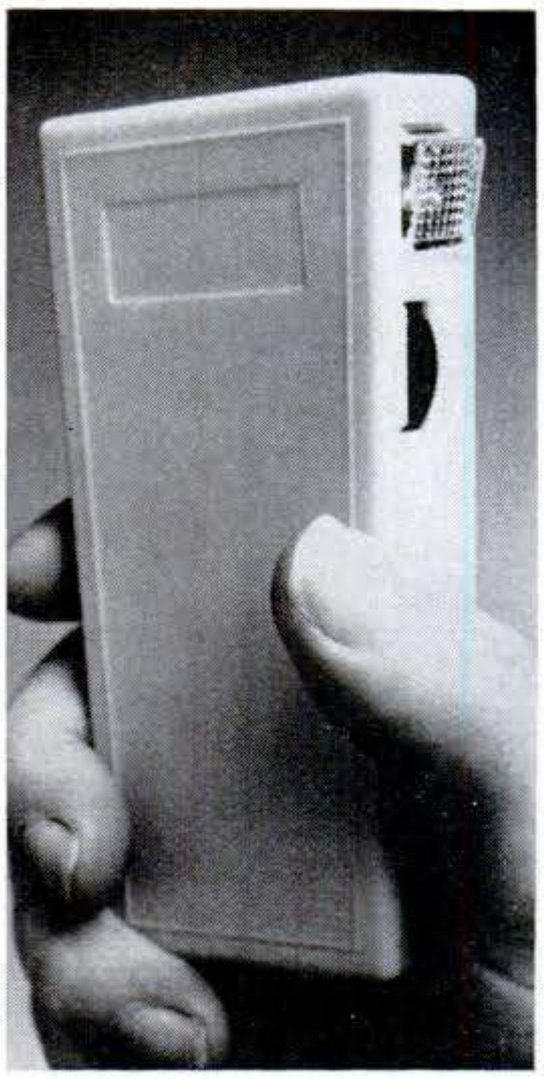
Big speaker

Dictaphone's new Dictamite 100 has an oversize speaker that gives better sound reproduction on playback, the maker claims. A built-in condenser mike gives optimum recording capability. Dictaphone Corp., 120 Old Post Rd., Rye, N.Y. 10580. It's $175.



Home-computer printer

Involved in home computers? The odds are you have a combination keyboard/TV display for getting data in and out of the system. That's great—but useless when you want messages or programs printed permanently. For that, you need a hard-copy printer like this one from Radio Shack. It takes paper widths up to 9.8 inches and prints up to 132 characters per line. Using a 5×7-dot matrix print head and ribbon cartridge, it creates all 64 standard ASCII characters. It connects to a computer using standard eight-bit parallel TTL circuitry. The price is $1299.95.



Pipe finder

Pass this palm-size metal detector over walls or floorboards and the indicator light will tell you where all the pipes, cables, and nails are located. It's sensitive to a depth of four inches. Brandon Clair Ltd., 21 Springfield Rd., Teddington, Middlesex, England.

Smoke alarm

When the alarm sounds in this clock radio, it could save your life. The Chelco SD 202 is a standard AM/FM digital—but with a built-in smoke detector. Price: $49.95. It's made by Chelco Sound Inc., 22 Craigwood Rd., Avenel, N.J. 07001.

Top-end CB

Keyboard channel entry, digital clock, electronic scanning for busy or empty channels, dual antenna control, single sideband operation—what more do you need? Just a license to run this new base CB rig by A.R.F. Products, Gardner Rd., Raton, N.M. 87740. $1095.

Remote control

Own a mobile CB rig? Then you also own half of a remote light-control system for your home. Key the transmitter within 300 feet of this Kronotek receiver and it will turn on anything plugged into it. It's $29.95. Distributor: CB Accessory Sales, 358 5th Ave., New York, N.Y. 10001.

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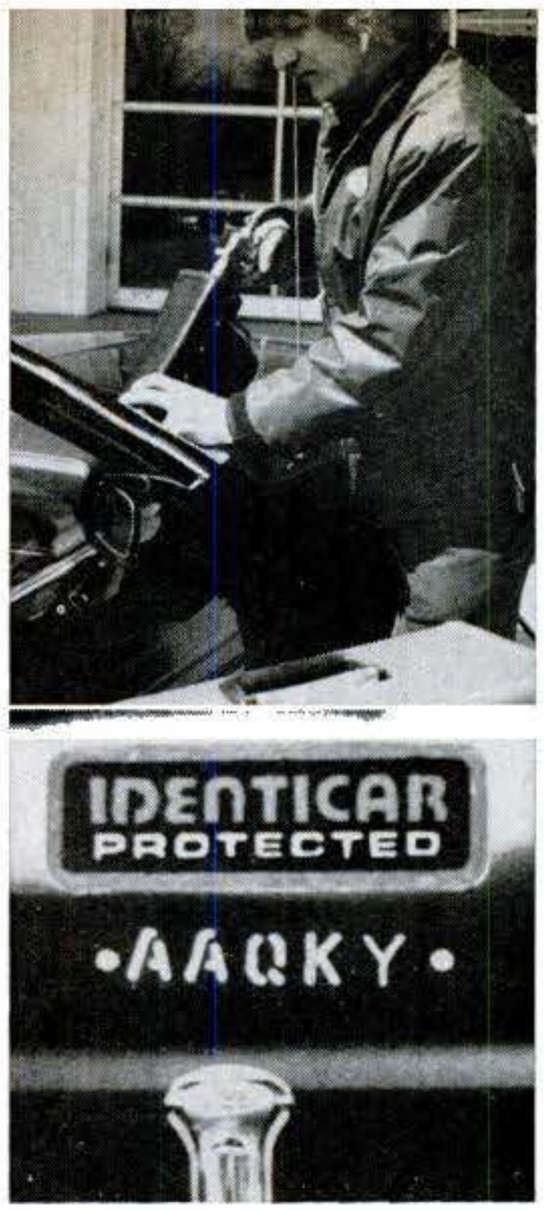
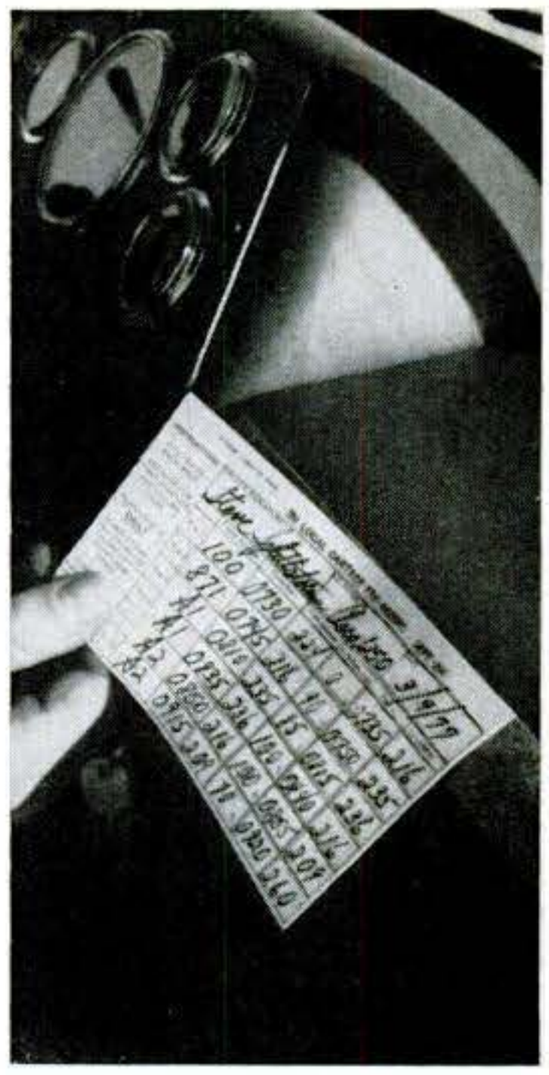
What's New
FOR YOUR CAR

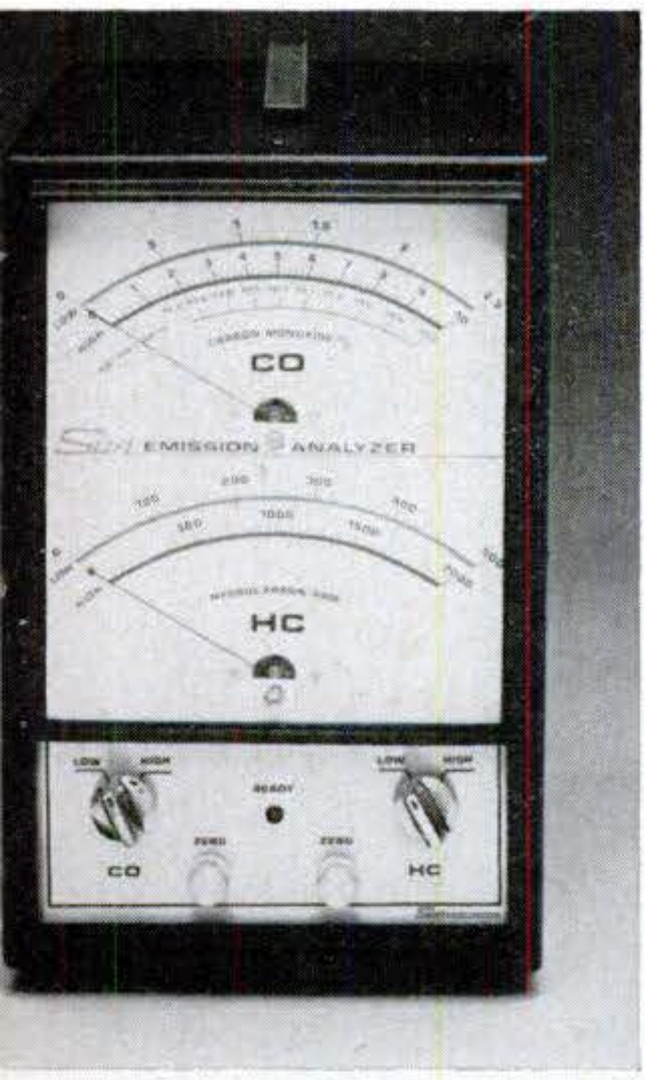
BY RICH CEPPOS

Tougher wax

Car-Plate liquid wax makes your car more resistant to surface rust than regular wax, claims Johnson Wax. Reason: Car-Plate is less porous than other waxes, Johnson says. It is applied like any other liquid car wax. A 12-oz. bottle, enough for three cars, is about $2.50.







Engine analyzer

Is your engine a polluter? Check it with the engine analyzer from Sun Electric (6323 N. Avondale Ave., Chicago, Ill. 60631). The 15-lb., $300 unit, powered by the car's battery, measures output of hydrocarbons and carbon monoxide via probe placed in tailpipe.

Electric paint

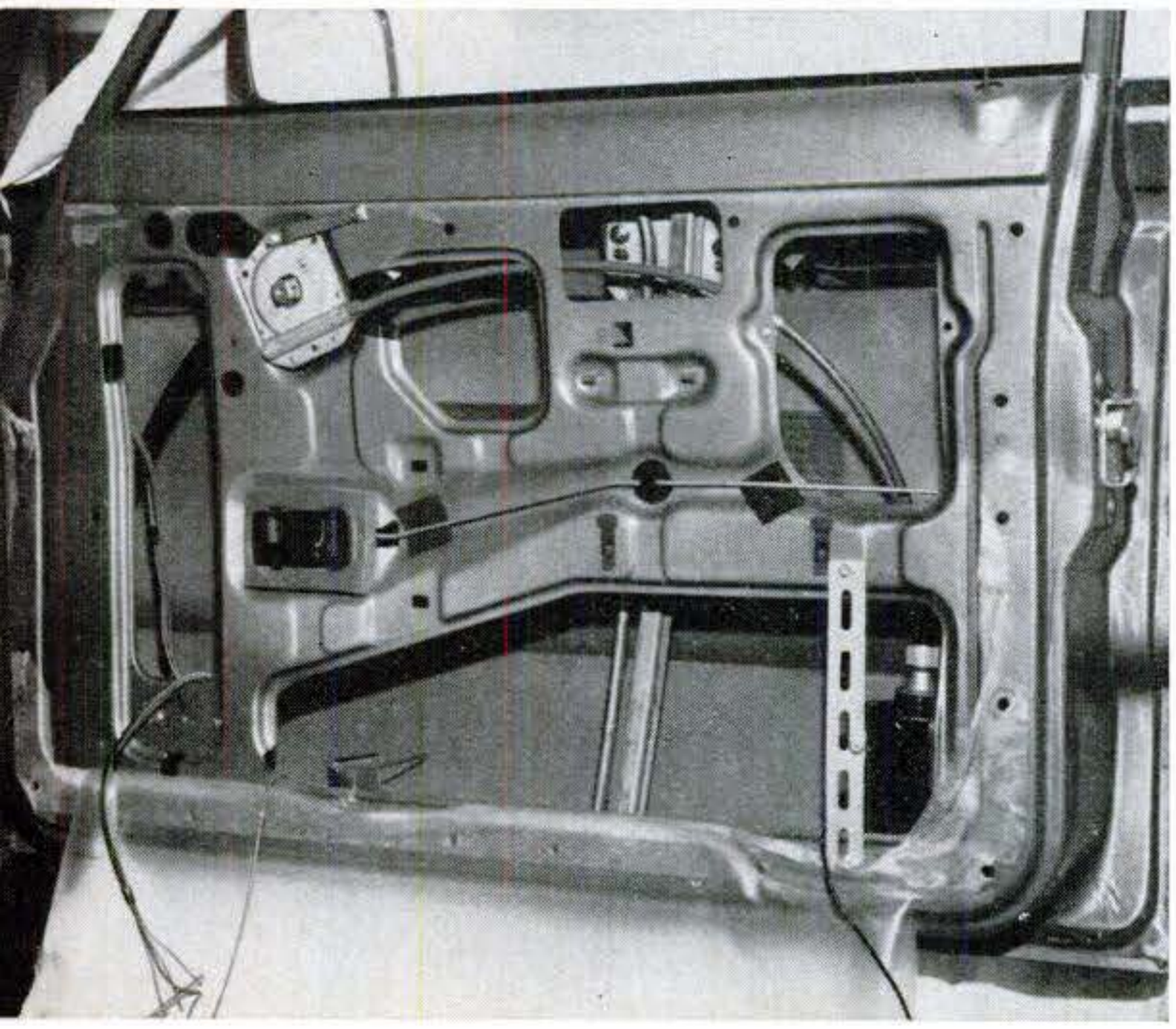
Damage your electric rear defogger element while cleaning the rear window? Silver paint forms a conductive film that heats up like the original element. A small bottle is $7 ppd. from Industrial Science Ltd., Leader House, 117 Snargate St., Dover, Kent, England.

Theft deterrent

Would a thief steal a car knowing he'd have to replace all the windows ($700 to $1000) before he got rid of it? Acme Glass (217 W. Central St., Natick, Mass. 01760) doubts it. Its Identicar system engraves all windows with a code (held on file for police). $29.95.

Stickemup

Need a convenient place to hold trip directions, maps, or toll tickets? Try a couple of strips of Scotch Post-It on the dash. It's a double-faced, pressure-sensitive, reusable tape that won't tear your papers when you remove them. The 3M tape is $1.98 for a one-by-two-in. roll.



Power windows

If cranking your windows up has you down, why not install add-on power lifts? A worm-gear drive over the original crank spindles couples to motor via flex cable. It costs less than factory units, claims the maker (Smiths Ind. Ltd., 50 Oxgate Lane, London NW2 7 JB).

Mobile compass

Airguide compasses have a powerful compensating system in the base that cancels magnetic interference caused by iron and steel in the car's body, says Airguide Instrument Co. (2210 Wabansia Ave., Chicago, Ill. 69647). Adhesive-backed, it mounts anywhere. Price: $12.

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PS editor flies the F-15 Eagle

By BEN KOCIVAR

ST. LOUIS, MO.

After seeing amazing flight demonstrations of the F-15 Eagle fighter in England, France, and Japan, I was eager for a ride. Now, fitted into a G-suit and strapped into a two-seater F-15, I tensed up.

Pat Henry, chief experimental test pilot for McDonnell Douglas, was in the front seat. "We'll do a Viking departure," Henry had just radioed Lambert Field tower. What he meant was a full-bore afterburner takeoff almost straight up.

The F-15's powerful twin turbines can put the Eagle at 50,000 feet about 10 seconds faster than the Saturn V that rocketed astronauts off to the moon.

"Ready?" he asked me.

My left hand felt the dual throttles shoved forward. Then I got a boot in the back that almost took my breath away. The acceleration lifted the research jet off the run-

Continued

"Getting a drink" from a KC-135 tanker, the McDonnell Douglas research F-15, with author Kocivar aboard, is snapped by photographer K. J. Holt with a Koni-Omega camera from F-4 Phantom. Head-on shot, left, shows enormous squarish engine intakes for two F-100 turbofans. Twin mounds between the two rudders are engine exhaust nacelles. Below, Kocivar and test pilot Pat Henry, right, emerge from the F-15's cockpit.

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In breathtaking "Viking" departure, F-15 Eagle zooms straight up after takeoff. Photo, left, taken with camera pointed back past the twin tails, shows Lambert Field. Above, inside the giant dome of the world's only two-to-one training simulator, pilot practices combat with two other fighters by means of a fast-moving projected image. Though the cockpit does not actually move, author Kocivar says visual sensations are so real they can induce motion sickness during simulated flights.

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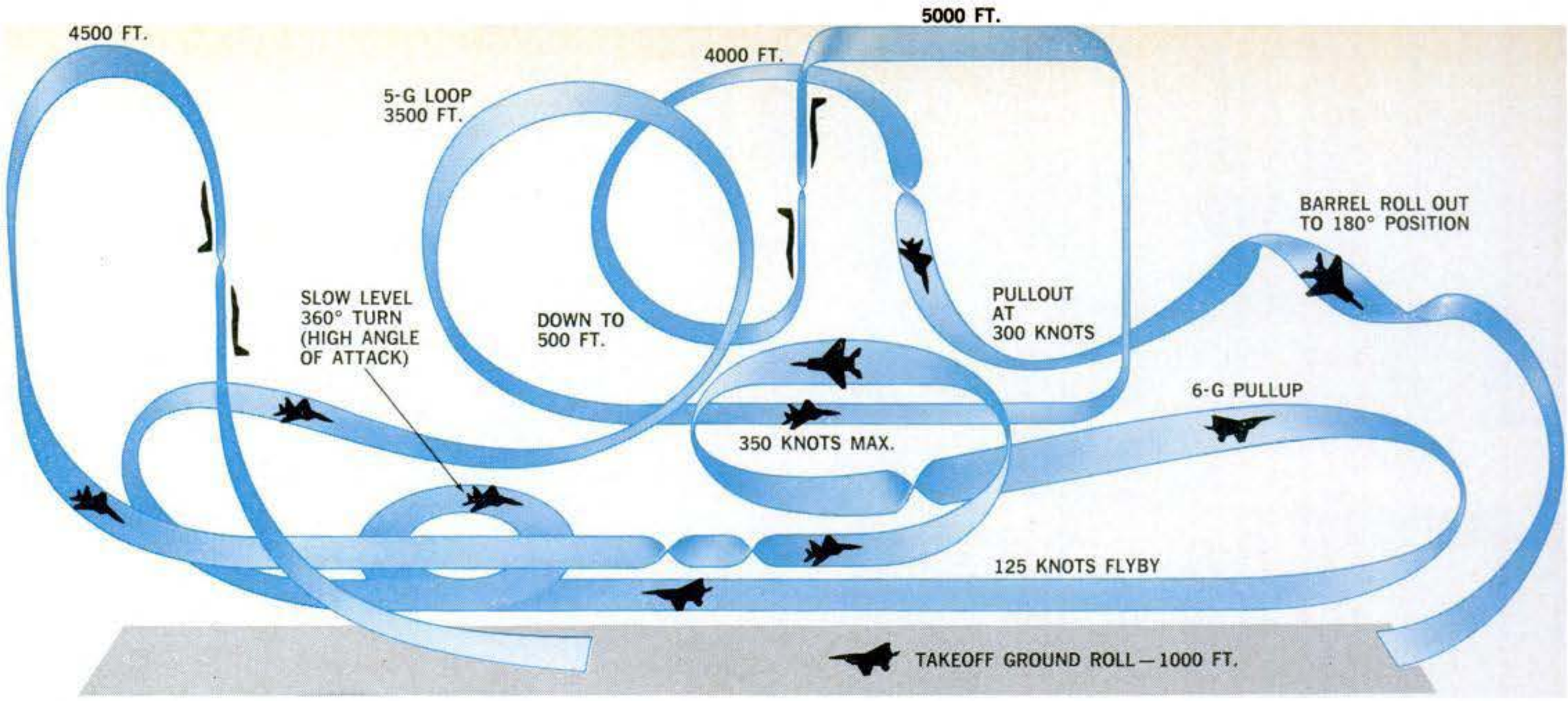

Pat Henry's intricate air-show maneuvers dramatize powerful F-15's impressive dogfighting ability in limited space.

way in less than 1000 feet. Abruptly, we aimed skyward at a 60-degree angle and 270 knots. We quickly passed 10,000 feet, rolled over on our back, and then rolled right side up again. The moves were so smooth and firm I felt we were on a hidden aerial track.

We throttled back and circled the area to give a single-seat F-15 and two-seat F-4 following us a chance to catch up. They were the "targets" for the flight, and soon snuggled in so close I could almost hop from one wing to the other.

"Getting a drink"

Radio and intercom chatter said we were being routed west from St. Louis to link up with an Air National Guard KC-135 refueling tanker. Years before I had "flown" the tail boom on one of these tankers. Today was my first experience at "getting a drink."

Radar helped get the two planes together. I watched Pat ease the Eagle up under the tanker belly. Pilots are directed to the correct refueling position by five pairs of lights under the KC-135 body. The telescoping refueling boom has two small control wings.

I felt a hair-raising tingle when the giant metal boom nudged in close to the canopy as we "idled" at 320 knots and 22,000 feet. But Pat held our position so steady during refueling I thought we were being "trailered" by the boom.

"Let's try some windups," Pat suggested when the other planes were fueled. He cleared a chunk of free airspace with traffic control, then rolled into an ever-tightening turn. My G-suit pressure expanded suddenly, squeezing my legs and stomach.

The Mach meter read 1.8—about 1100 mph—and the G meter started nibbling over three. My head was being pushed down into my shoulders; I had a faint sense of "greying out."

We must be approaching a high-speed stall, I thought, expecting to feel some wing buffeting. But it never developed. Later, Pat said he could have wound the Eagle into an even tighter turn without stalling it. F-15's have flown at nine G's.

Our ship was fitted with new FAST packs (fuel and sensor tanks) on the outer sides of the fuselage that curtailed extreme performance tests. These packs, also suitable for cargo, reconnaissance or electronic-countermeasures gear, reduce top supersonic speed but do not increase drag at subsonic speeds. Two tanks can boost the F-15's fuel capacity from 11,000 to 21,000 pounds. With them, the aircraft has been flown subsonically from Maine to England in 5½ hours without refueling.

Pat asked me what I'd been waiting to hear: "Want to fly her a bit?" At first, I tried some mild windup turns and pushovers to get the weight-reducing feel of negative G's. It was incredibly smooth. I felt the Eagle's 50,000 pounds of thrust could make it go wherever I pointed the nose. In fact, that much power, and the plane's 41,500-pound operating weight, makes it the only plane in the world that accelerates going straight up.

The F-15 has set eight time-to-climb records. In one flight, it reached 98,425 feet in 208 seconds. During this flight, the Eagle continued in a nearly ballistic path to 102,400 feet. It then fell back into denser atmosphere.

Throughout this earlier flight the F-15 was reportedly stable. But I asked Pat Henry what would have happened if the Eagle had fallen into the denser atmosphere without aerodynamic control. My question led Pat to ask if I'd like to try a tail slide. I wished I'd kept quiet. I had heard of planes falling back into uncontrollable flat spins that led to baleouts.

Pat explained we'd head straight up without afterburners but at full military power—the throttle setting most planes use for takeoff. We pulled up from about 32,000 feet.

Throttle up—and a tail slide

Slowly, we came to a hanging stop. We were at 42,000 feet. Then, throttles still blasting at military power, we started sliding backwards. We slipped through a white cloud our vapor trail had created on the way up. Bits of dust began floating off the floor.

It seemed we were going to fall over backwards. Gradually, in a sort of speed-up slow motion, the plane's nose pitched forward past the horizon. Now we were pointed straight down and picking up speed very fast.

My stomach was still back there at 42,000 feet. Although I could not see it, I felt us begin to level off. As the G's built up, my pressure suit inflated. And then, almost as abruptly, the forces eased as we leveled out.

It didn't seem real. We had just fallen backwards more than two miles, then rammed ahead with full throttle. I got a quick flash at the altimeter: 30,000 feet. Pat gave me a minute to recover, then said, "Want to try some more?"

"Let me try a roll or two," I

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said. Gingerly I moved the control column to the right. We went through a sloppy roll effortlessly.

Pat offered to show me a full-aileron roll. After that tail slide, what could I lose? I grunted a "ready," then felt my dual-control stick shoved quickly to the right. My head snapped to the left. The roll was so fast it was completed before I knew we had started. Our speed was about Mach 1.2.

My initial reaction was that a snap maneuver like this might overstress even fighters. But Jack Krings, chief test pilot for McDonnell Douglas, said structural problems would be more likely with designs that produced a dive or violent turn from a fast roll.

By now we'd been airborne for almost two hours. Pat asked, "How about a few touch-and-go landings?"

We got clearance for Scott Air Force Base, near St. Louis. As we came in, I followed Pat's very slight control movements with my hands lightly on the throttle and stick. We slid toward the runway at about airliner speed and touched down so smoothly I couldn't tell whether we'd been kissed by an air movement or the wheels had touched the runway. They'd touched, because Pat shoved the throttles forward, we rolled briefly, then blasted skyward.

A short time later we approached Lambert Field for a full-stop landing. I was curious to see how Pat would slow the Eagle without reversers or a drag chute. The F-15 has a giant speed brake, an almost vertical flap that comes up from the fuselage between the engines.

Pilots pop this brake to slow down quickly at high speeds, prevent too much speed buildup in a dive, and slow down during a landing approach. Unlike the wing-top spoilers on many planes, the F-15's brake does not kill wing lift. Pat raised the speed brake as he put the landing gear down.

The Eagle's final approach speed is about 135 knots; touchdown is at about 120 to 125 knots, depending on weight. With its light wing loading the F-15 reacts to slight gusts. It's possible for it to touch down and then skip up again. There are no automatic wing spoilers to kill lift when the wheels touch.

Once we were down and rolling, Pat held the nose up, using the flat surface of the wing as a huge aerodynamic brake. An indication on the HUD (head-up display) tells the pilot not to exceed 15-degrees nose-up to avoid scraping the tail.

Advanced-technology HUD

I was impressed with the Eagle's flight capabilities. But the aircraft's advanced-technology HUD was equally impressive. HUD information is a digital projection of cockpit instrument information displayed on two small glass plates just inside the windshield. In critical situations, a pilot need not shift his attention between the instrument panel and the windshield.

The HUD Concept will inevitably be incorporated in airliners.

During our simulated runs on the target planes that had flown with us, Pat saw target information on the HUD. (I noted the combat advantage of the F-15's smokeless engines during these runs. The F-4's trail of black smoke made it visible miles away.)

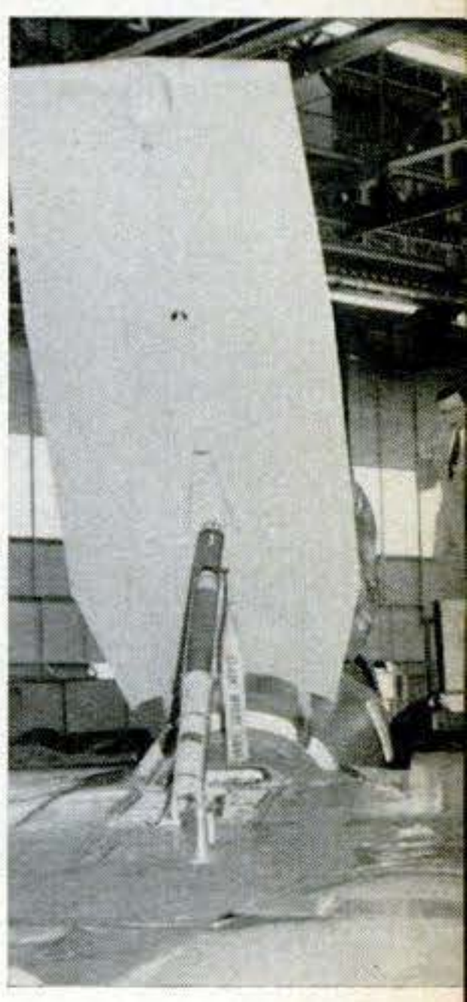
The HUD display has a small circle with cross markers that shows the F-15 flight path regardless of wind strength and direction. A symbol slaved to the nose radar antenna designates targets over 100 miles away. HUD also shows the F-15's weapon status, speed, G-load, airspeed, altitude, and heading, plus additional target and weapons data.

Instead of targets, civilian HUD's might display air traffic for pilots to avoid, and weather data, instead of missile status. The HUD and other technology built into the Eagle allows pilots' work capacity to increase without overloading.

Finally, as Jack Krings pointed out, the F-15 program shows that fast, stable, highly maneuverable planes can also be easy to fly. PS

VITAL STATISTICS OF THE F-15

Length	63.75 ft.
Wingspan	42.81 ft.
Height (tail)	18.45 ft. from ground
Operating weight	41,500 lbs. (full fuel plus 4 Sparrow missiles)
Top speed	Mach 2.5+ (about 1700 mph)
Combat thrust-to-weight	1.4 to 1
Angle of attack	+120 degrees to −60 degrees
Engines	Two F-100-PW-100 "smokeless engines"
Avionics	High-power multi-mode radar Head-up Display ECM and ECCM (electronic countermeasures and electronic counter-countermeasures)
Flight controls	Hydromechanical with fly-by-wire backup
Cost	$14-15 million (including research and development)



Hefty tail hook on Air Force fighters snags runway barriers in case of overshot landing. Eagle has speed brake (below) but no engine thrust reversers or pop-out drag chute to slow it down.

Top-mounted monster speed brake is 3½ by 9⅓ ft. Using graphite here and boron in rudder saves 265 lbs., compounding into total 848-lb. saving because less strength is needed to support lighter structure.

Oxygen-mask check insures that mask does not leak and that helmet fit is snug but not too tight. Author's beard posed a question about possible mask leakage, but test revealed this was not a problem. His pressure suit inflates automatically.

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Sleek, lightweight, versatile

RV's for '78

Clamshell-opening Barr Truck Top flips open to create a roomy camper that sleeps four adults easily. It costs $1595.

Stylish new fiberglass Sunrader pickup camper weighs 1150 pounds and fits on small import pickups. The manufacturer claims combined rigs get about 20 mpg. Price is $8995.

Tiny trailer is 13½ feet long and weighs 1190 pounds—small cars can tow it safely. Play-Mor 135 sleeps four and has a full galley. It's $1950.

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Turned off by gas guzzlers? These RV's offer a high-mpg alternative

By HERBERT SHULDINER

A new generation of high-mpg campers and trailers is being introduced this year, and these RV's offer an appealing alternative to the typical gas-guzzling motorized camper.

The new self-propelled recreational vehicles get over 20 mpg in some instances, while the trailers are designed to be towed by small, fuel-efficient cars.

This trend to lightweight, fuel-stretching RV's runs counter to the mainstream of camper offerings. Bigger motor homes and trailers that give six to 12 mpg are still the best sellers in the RV market.

That's why RV manufacturers are still overwhelmingly convinced that most motorized camper buyers prefer big, comfortable rigs, rather than more fuel-efficient ones. "In fact, consumer preferences today are delaying the introduction of more lightweight RV's," says Elden L. Smith, vice president of Fleetwood Enterprises' RV division, the biggest camping-vehicle manufacturer in the U.S. Smith claims that small trailers produced by the major companies aren't selling—"at least not in the volume we like to make them in."

Despite this, at least one major RV company—Airstream—has new models that represent the most dramatic advances in lightweight trailer construction yet. Its Argosy division introduced a 20-foot Minuet model last year with a dry weight of 2500 pounds—remarkably light for a fully self-contained (except for a shower water-holding tank) trailer of that size.

For '78, Argosy offers a new 22-foot Minuet that weighs only 225 pounds more than the 20-footer, and can also be towed by compact cars. One drawback to the Minuets, however, is their high price: $6525 for the 20-footer; $7350 for the 22-footer. That's way above the median price for trailers of that size.

Continued

Super-light Argosy 20-foot trailer weighs only 2000 pounds, can be towed by compacts. It's the lightest trailer of its size, and the most expensive.

Compact Trillium 4500 weighs 1375 pounds and has hitch weight of only 110 pounds. It sleeps four and offers a complete kitchen. Price: $4400-5400.

New look in mini-motorhomes was pioneered by Fleetwood Enterprises' Tioga II. Only 16' 9" long, yet it's fully self-contained and sleeps four. $10,814.

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Futuristic-looking Pont-X SR 2 has an aerodynamic fiberglass body to reduce drag. It sleeps four, has full galley. Mounted on Toyota, price is $9995.

Low-profile Chinook Omega is only 7'6" high. Dropped step in rear gives 6'2" interior headroom. The $9500 rig gets about 20 mpg on highway. It's 17'6" long.

New lightweight camping trailer by Coleman, the Rebel is made to tow behind small cars. It sleeps five, and has a complete galley. Price is $1895.

The increasing number of micro-mini-motorhomes this season means more fuel economy in this RV category. The micros get three to four mpg more than standard minis—a 30 to 40 percent increase in economy. Fleetwood's Tioga II, first of this type, has been joined by a large number of new models this year—including Arrow, Flair, and Jamboree models by the same maker. Champion's two new Grand Slam models, Coachmen's Cadet 17, and Cobra's Beachcomber are other new micros for '78.

The best immediate promise for fuel economy in self-propelled campers is to mount them on the highly fuel-efficient Japanese light pickup trucks. And there are quite a few new rigs built on the Toyota chassis this season. Chinook, which pioneered this type of vehicle, has two new models this year—including the Omega (at left). The Pont-X (top) and Barr Truck Top are two other versions that offer 20-plus mpg performance. PS

WHO MAKES 'EM

Argosy, 60 Vista Rd., Versailles OH 45380; **Barr Truck Top,** 8775 Olive Lane, Santee CA 92071; **Chinook Mobilodge, Inc.,** 567 San Nicolas Dr. #301, Newport Beach CA 92660; **The Coleman Co.** Camping Trailer Div., Somerset PA 15501; **Play-Mor,** Westphalia, MO 65085; **Pont-X,** Ponteix Products, Ltd., 5441 E. La Palma Ave., Anaheim CA 92807; **Sunrader,** Gardner Pacific Corp., 5415 Napa-Vallejo Hwy., Vallejo, CA 94590; **Tioga II,** Fleetwood Enterprises, Inc., 3125 Myers St., Riverside CA 92503; **Trillium** Recreational Vehicles Ltd., 25 Heritage Rd., Markham, Ont., Canada L3P 1M3.

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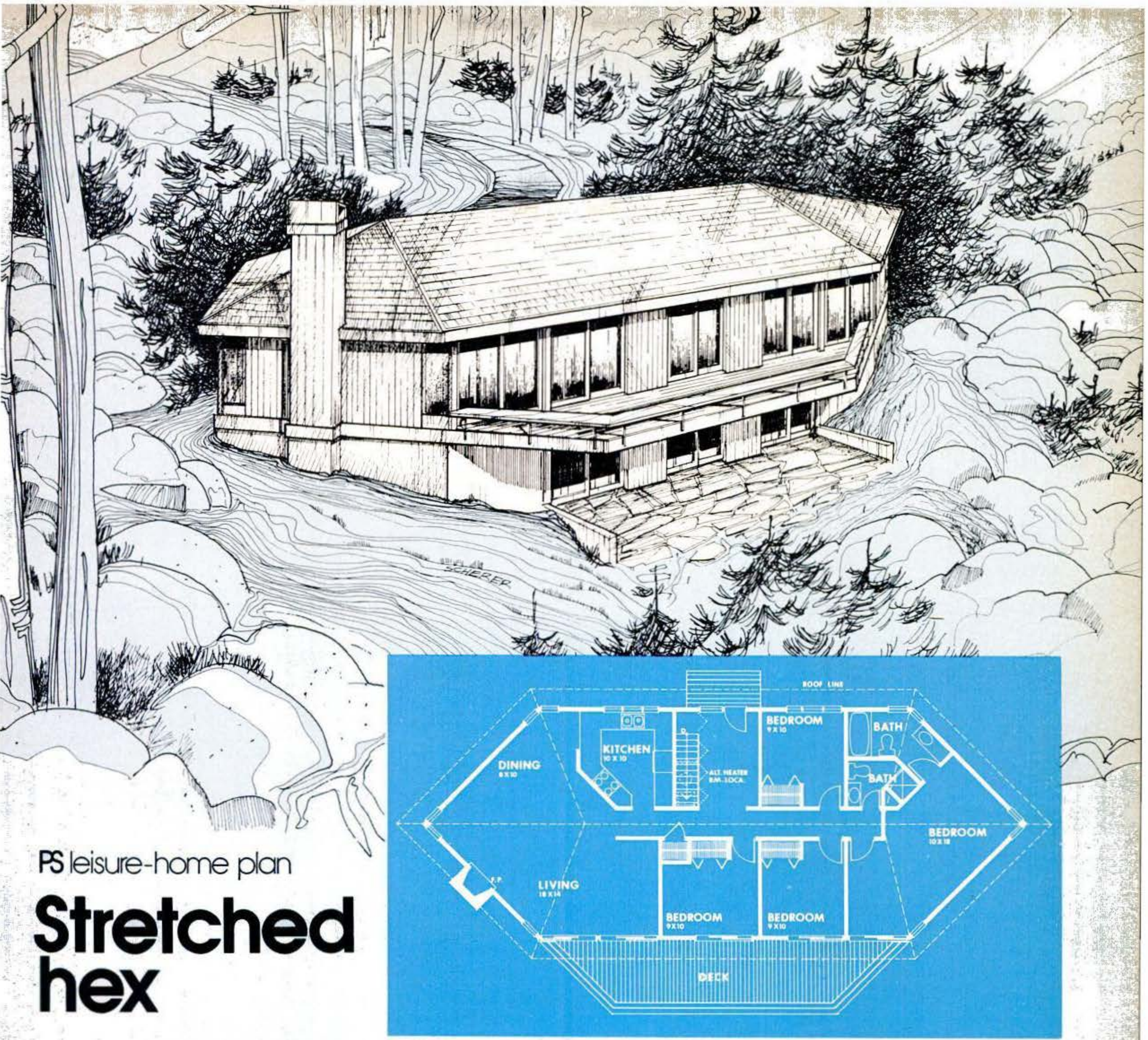

PS leisure-home plan

Stretched hex

Though the double-prow plan introduces architectural excitement, it doesn't upset the logic of this floor plan. The center partitions are at conventional right angles to simplify construction and the placement of furniture. Only the kitchen and the two baths have skewed walls to match those pointed ends that add drama to the living-dining area at the left and the master bedroom at the right.

The six-plane roof (dotted lines on plan) is not much more difficult to frame, sheath, and shingle than a conventional hip roof. And the sloping ceilings on the underside contribute to the visual interest of the interior.

In our artist's sketch, the house is set into a slope, with a partially excavated basement. This lower floor would be an ideal activities area for cool or wet days. For a beach site, it would make a fine dressing area (with direct access from the patio), sparing the main house those parades of dripping bathers. Note on the plan that the stairway to this lower level is shown as an alternate. For a single-level house this space becomes the utility area, with water heater and furnace concealed behind folding doors. The cantilevered deck expands livability and eases traffic flow by being accessible from three of the four bedrooms and the living room.

The house was designed for POPULAR SCIENCE by Robert Martin Engelbrecht of the V-PAC Council, a group of manufacturers promoting quality leisure-home plans.—*Al Lees*

V-PAC Council members—their specialties

American General (prefab stairs); Andersen (windows, gliding doors); Darworth Inc. (stains, preservatives); Du Pont (interior finishes); Frigidaire (kitchen appliances); GAF (roofing); Georgia-Pacific (paneling, doors); Heatilator (fireplaces); Johns-Manville (insulation); F. E. Myers & Bro. (water-pump systems); Pass & Seymour (wiring devices); Simpson Timber (decking, siding); Singer (heating); United Farm Agency (land resources); Universal-Rundle (bathroom fixtures).

Several ways to order V-PAC plans

Stretched-hex study plan ($1) is enlarged floor plan with added data. Plans from earlier series—plus others not published in PS—are catalogued in V-PAC Guide ($3). Stretched-hex plans (VPS #42) are $40, three sets $55, five sets $65. Blueprint postage and handling: in U.S. $1.50, elsewhere $2.50. Send orders to Vacation Plans Service, Box 622, Princeton, N.J. 08540 (U.S. funds only).

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Space saver for cramped bedrooms: L-shaped bunks

Right-angle bunk-bed unit features built-in desk, generous storage drawers. And while you're at it, finish your bedroom redecoration with a fabric wall

By RICHARD STEPLER
DESIGNS BY GARY GERBER, IDSA

This handsome bunk bed turns a corner to fulfill three functions in a small bedroom:

- It provides comfortable sleeping for two; access to the upper berth is via full-width dowels at right.
- A desk/study area is tucked next to the lower bunk—a handy spot for telephone and directory.
- And there's ample storage for toys or bedding in two generous drawers that stow under the lower bunk.

While Gary Gerber's L-shaped bunk *looks* as if it would take the skill of a master craftsman, construction is straightforward—you use 4-by-4's for corner posts and birch-veneer plywood for side supports.

And, to make a small bedroom a real *tour de force*, add a rolling fabric wall as a backdrop. For construction details on both these projects, see the drawings on the facing page.

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How to build the L-shaped bunk

PLATFORM SUPPORTS UP 4 INCHES FROM BOTTOM FOR FOAM MATTRESS TO PROVIDE INCREASED HEADROOM FOR DESK AREA

$3\frac{1}{4}$" x $3\frac{1}{4}$" x 71" CEDAR (5 REQ'D)

$1\frac{1}{4}$" x $81\frac{1}{2}$" WOOD DOWEL

2" LAG BOLTS WITH WASHERS (38 REQ'D)

RUBBER FOAM MATTRESS

$\frac{3}{4}$" x $39\frac{1}{2}$" x 77" PLYWOOD (2 REQ'D)

$1\frac{1}{4}$" x 41" WOOD DOWEL

59"

$\frac{3}{4}$" x $7\frac{7}{8}$" x 85" (4 REQ'D)

$\frac{3}{4}$" x 2" x 77" (4 REQ'D) SET $4\frac{3}{4}$" UP FROM BOTTOM

SEE DESK DETAIL

$\frac{3}{4}$" x $7\frac{3}{4}$" x $47\frac{1}{2}$" ATTACHED WITH LAG BOLTS

$3\frac{1}{4}$"

$\frac{3}{4}$" x 2" x 38" PLYWOOD (4 REQ'D)

11"

$1\frac{1}{4}$" WOOD DOWELS SPACED ON 11" CENTERS EACH 44" LONG (5 REQ'D)

FLOOR TO BED FRAME - 11"

$\frac{3}{4}$" x $7\frac{3}{4}$" x $47\frac{1}{2}$" (4 REQ'D)

ROLL-OUT DRAWERS SEE DETAIL

BUNK BEDS EXPLODED VIEW

$3\frac{1}{4}$" x $3\frac{1}{4}$" x $23\frac{1}{2}$" CEDAR (2 REQ'D)

$\frac{3}{4}$" x $3\frac{1}{4}$" x $32\frac{3}{4}$" (2 REQ'D)

8-PLY $\frac{1}{2}$" PLYWOOD DRAWER GUIDE $3\frac{3}{4}$" x 4" x 38"

OPTIONAL PEG-BOARD PANEL $\frac{3}{4}$" SPACING AROUND PEG-BOARD FRAME

$\frac{3}{4}$" x $28\frac{1}{4}$" x $30\frac{1}{4}$" (4 REQ'D) SET $1\frac{5}{8}$" UP FROM BOTTOM - PLYWOOD

$\frac{3}{4}$" x 1" NOTCH

$\frac{3}{4}$" x $1\frac{1}{2}$" x $28\frac{3}{4}$" (4 REQ'D)

$\frac{3}{4}$" x 24" x $34\frac{1}{2}$" FORMICA TOP AND EDGES

$22\frac{3}{8}$"

$27\frac{1}{4}$" DESK HEIGHT

$2\frac{9}{16}$"

$\frac{3}{4}$" x $1\frac{1}{2}$" x $1\frac{1}{2}$" (4 REQ'D)

$\frac{3}{4}$" x 10" x $30\frac{1}{4}$" (2 REQ'D)

$\frac{3}{4}$" x $7\frac{7}{8}$" x 24" FORMICA OUTSIDE AND EDGE

$\frac{3}{4}$" x 10" x 29" (4 REQ'D)

DRAWER DETAIL (2 REQ'D)

DESK AREA DETAIL

$\frac{3}{4}$" x 10" x $32\frac{1}{2}$" (2 REQ'D) FORMICA-FACED ON FACE AND EDGES

$\frac{3}{4}$" x 4" x $19\frac{7}{8}$" FORMICA TOP AND EDGES

2" CASTER (8 REQ'D)

$\frac{3}{4}$" x $3\frac{1}{4}$" x $21\frac{7}{8}$" (2 REQ'D)

$\frac{1}{4}$" x $28\frac{1}{4}$" x $30\frac{1}{4}$" PLYWOOD (2 REQ'D)

1 x 6 PINE BOX (ASSEMBLE TWO PIECES FIRST - THEN ATTACH THEM TO BLOCKING)

$5\frac{1}{2}$"

$5\frac{1}{2}$"

STOCK RUBBERMAID DRAWER

1 x 3 PINE BLOCKS

FACIA AND BLOCK SECT. DETAIL

9"

1 x 10 CEDAR FACIA (ATTACH WITH FINISHING NAILS)

ANGLE BRACKET ATTACHES DESK TOP TO SIDE

SLIDING DOOR TRACK

1"

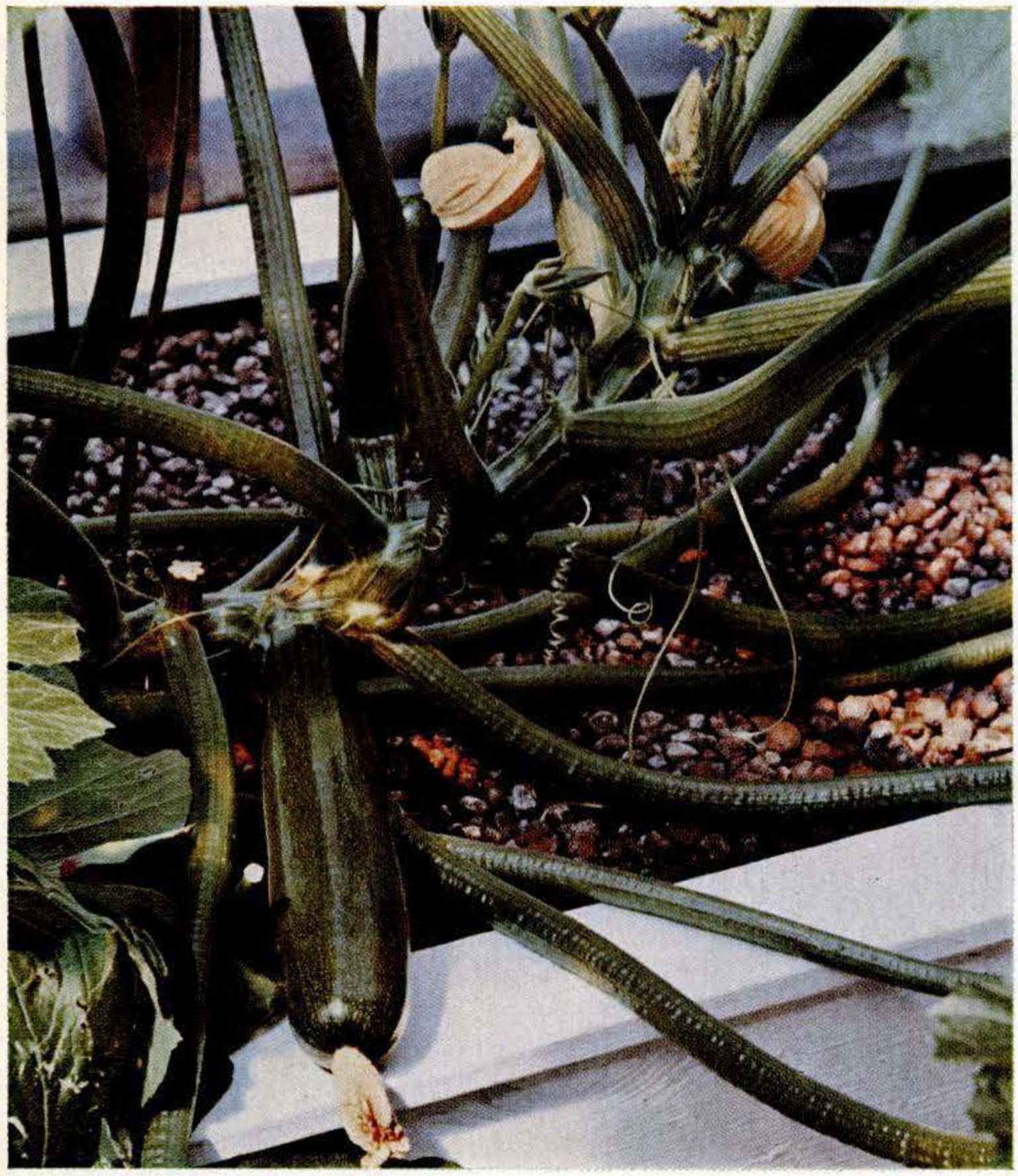
3' x 6'-8" HOLLOW-CORE LUAN DOORS

STRETCH FABRIC AROUND THE DOOR AND STAPLE IN BACK

FABRIC WALL ASSEMBLY

NOTE: BEFORE ATTACHING FACIA BE SURE THAT THE DOORS CAN SWING OUT ENOUGH TO ENGAGE ROLLERS IN SLIDE TRACK

Fabric wall: Fabric-covered hollow-core doors hang on sliding-door hardware that's concealed behind cornice.



Tomatoes, zucchini, cucumbers—all grow profusely in Herrington's hydroponic greenhouse (top and left). For maximum use of space, cucumbers are tied to suspended strings. Vertical hydroponic system (above) was developed by Paul Droll for leaf crops, which take a lot of space. Seedlings in cellulose blocks are put in small holes in PVC pipes. No growing medium is used here; continuous drip of nutrient keeps roots moist. Droll will market the system in kit form.

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How to grow lush gardens without soil

Hydroponics lets you grow more and better plants with less work

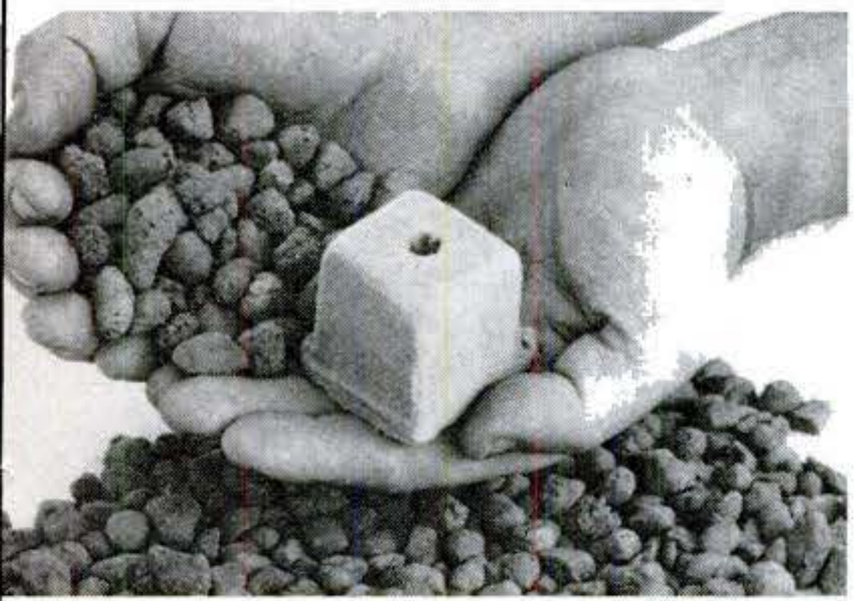
By V. ELAINE SMAY

Ken Herrington has a problem with his greenhouse when he leaves it unattended for a couple of weeks. That's not surprising since plants—especially those grown indoors—need frequent attention. But Herrington's problem is unusual: "I have to hack my way in with a machete," he says with real dismay. Without frequent pruning, his tomatoes grow over the door.

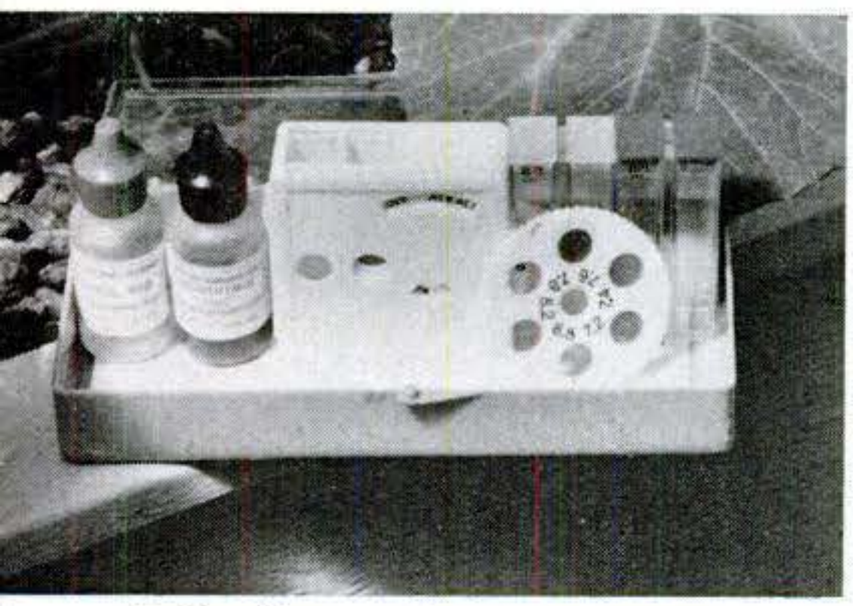
The secret to Herrington's success: hydroponics. His plants grow not in soil, but in an inert aggregate that offers no nutrient at all to the plants. Instead, all the 16 elements a plant needs are mixed with the water, which is periodically pumped to the roots.

Interest in hydroponics has been growing rapidly. Today there are commercial hydroponic farms in the U.S. and throughout the world. And multitudes of homes have small hydroponic systems. There are good reasons for the increasing popularity of these soilless gardens:

- You get faster growth and earlier harvests because the plants are perfectly nourished.
- You can grow more plants in a given space because you don't need room for an elaborate root system.
- You use less water in hydroponic gardening because the nutrient solution is recycled many times.
- No fungi or soil-borne diseases or pests are likely to get a start.
- There's no backbreaking work —no spading, hoeing, or weeding.



Growing medium is lightweight aggregate (this is ½" size). Cellulose growblocks are used for starting most seeds; seedlings in blocks can be transplanted into aggregate. If started in soil, roots must be thoroughly washed. Timer (right) turns on pump to flood growing beds periodically with nutrient solution.



Daily pH test of nutrient solution is recommended for best results. Kits are sold at hydroponics supply houses. Swimming-pool kits are not appropriate.

For root crops, smaller-size aggregate is preferred. This is ⅛" size. Root crops will do well in hydroponics as long as weather is cool.

How it works

Before we get into specifics about hardware and technique, take a moment to review a few basic principles. Paul Droll, a commercial hydroponic-greenhouse consultant and Herrington's mentor on his project, explains the theory this way: "In conventional gardening, micro-organisms take the organic matter in the soil and break it down. The roots of the plant must

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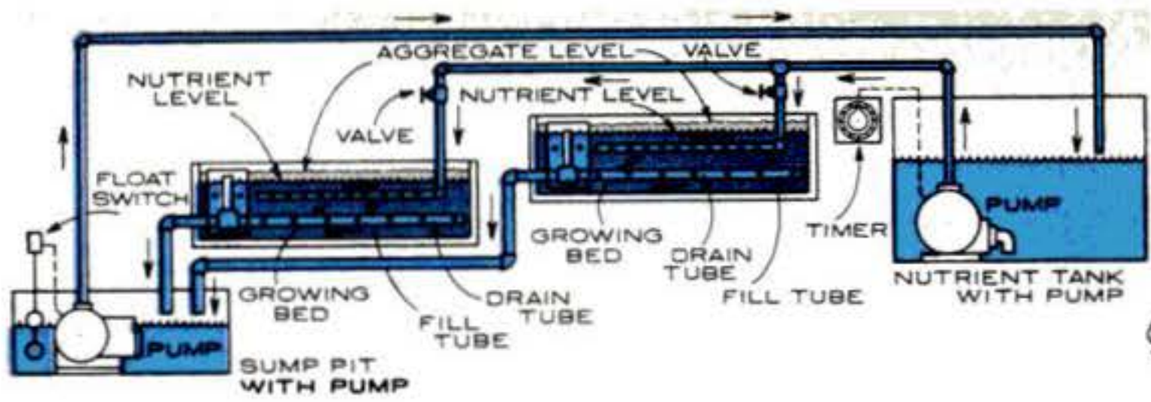
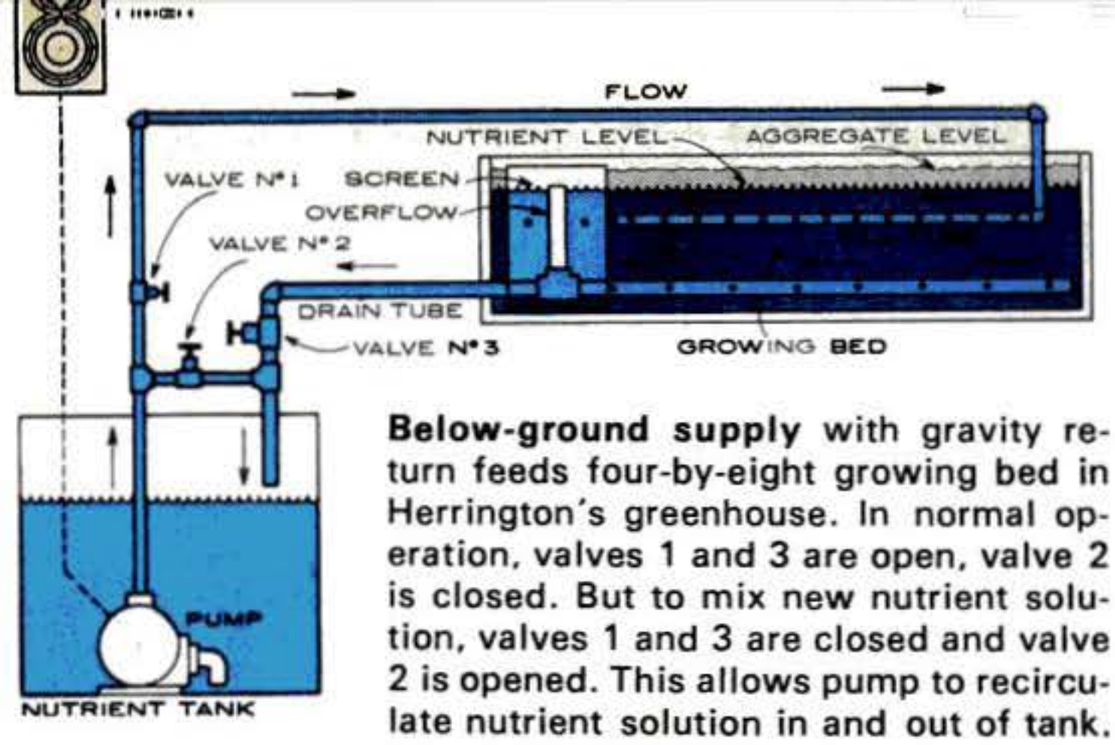


Pump, activated by timer, moves nutrient to filling tubes, which have 1/8" holes every 2½"; drain tubes have 1/8" holes every 6". Beds drain while they're filling, but fill faster, so solution rises to desired level. After 15 minutes, timer stops pump and beds drain. Float valve activates pump in 20-gallon sump to return nutrient to reservoir.



Below-ground supply with gravity return feeds four-by-eight growing bed in Herrington's greenhouse. In normal operation, valves 1 and 3 are open, valve 2 is closed. But to mix new nutrient solution, valves 1 and 3 are closed and valve 2 is opened. This allows pump to recirculate nutrient solution in and out of tank.

then seek out the minerals that result and absorb what they need in ionic form. In hydroponics, a perfectly balanced nutrient compound is mixed with the water and delivered directly to the roots. The plants absorb the necessary elements, again in ionic form, but with the least amount of trouble."

Setting up a hydroponic garden can be as simple—or about as complex—as you want to make it. All you really need is a reservoir for the nutrient solution, a container for the plants, and some kind of growing medium—an inert material that will support the roots, keep them moist between feedings, and allow aeration. Washed pea gravel is an ideal growing medium where weight is not a concern. Cinders, brick chips, and coarse sand are also good and will last indefinitely. Where weight's a problem (on rooftops, for example) perlite (expanded volcanic glass) or vermiculite (expanded mica) can be used. These are lightweight and absorbent, but will only last a year or so.

The containers, too, can be just about any material, as long as they're waterproof and of a material that isn't toxic to plants. (Avoid galvanized iron or tin; the zinc can poison the plants.)

All hydroponic systems must provide a means of feeding the plants with the nutrient solution. Most do this periodically. The frequency may range from once a day (or even less) to four times a day, depending on what plants are grown, their size, the temperature and humidity of the growing area, and the absorbency of the growing medium. Such a system can be as simple as a pot filled with growing medium through which you periodically pour the solution, catching it as it runs through drainage holes in the bottom. More convenient systems use pumps to circulate the nutrient to the growing bed. Pumps can either be hand-activated or, for complete automation, a timer can be used.

A couple of hydroponic systems feed the plants constantly instead of periodically. One uses wicks made of synthetic fabric to draw solution from the nutrient reservoir into the growing bed above. Another is called the continuous-drip method; as the name implies, this slowly but constantly drips the nutrient solution onto the growing bed. You can buy home-hydroponic units that use variations of any of these systems, and it's easy to design and construct your own.

Herrington's system

Ken Herrington, a professional photographer (he took all these pictures except the one of Droll's vertical units), is also an amateur experimenter, and designed his own hydroponic system for the solar-heated greenhouse he built at his Napa, Calif., ranch. You may remember Herrington from other PS stories. We've featured both a fireplace heater he designed [PS, July '75] and his DIY solar water heater [PS, May '76] in our Adventures in Alternate Energy series.

His hydroponic systems (he has a couple going) use submerged pumps to deliver the nutrient solution periodically to the growing beds, and gravity to drain it out. ("A plant doesn't like to stand around with its feet wet," he notes.) The two growing beds shown in our photos are fed from an above-ground nutrient reservoir. A separate four-by-eight foot tray uses an underground reservoir. Herrington wanted an above-ground tank primarily because of the additional thermal storage it provides for his greenhouse. Herrington keeps 200 gallons of solution in the four-by-four-foot-by-32-inch tank. An above-ground reservoir is also advantageous where digging a large pit would be difficult or expensive. But the underground reservoir allows a slightly simpler plumbing scheme (see diagrams).

Herrington's growing beds are framed with exterior-grade plywood, which he coats with epoxy resin. The curved bottoms of the trays are made of five-ounce fiberglass. The construction is surprisingly simple and strong. The four-by-eight tray, Herrington reports, holds ¾ ton when flooded.

The nutrient reservoirs are also made of epoxy-coated exterior plywood. Vinyl liners—the same kind you use in swimming pools—make them watertight. All the plumbing is done with PVC pipes and valves.

For the growing medium, Herrington uses a lightweight aggregate made of expanded slate (it has air cells in it). It's light in weight, inexpensive, and comes in a variety of sizes.

A timer automates the feeding of the plants. The diagrams above show how the systems work. Herrington floods the growing beds four times a day: at 8 am, 12 noon, 4 pm, and 7 pm. The residual water on the aggregate sustains the plants between feedings.

To avoid algae formation in hydroponic growing beds, it's important that the nutrient solution never reach the top of the growing medium. Herrington's system regulates the nutrient level with a vertical overflow tube that ends one inch below the top of the aggregate. It's isolated from the aggregate by a perforated fiberglass collar (see photo). He doesn't glue the overflow tube into the T-fitting. Thus he can change its depth and the depth of the aggregate to suit whatever crops he is growing. He also leaves the elbow of the drain tube (where it bends downward on the way to the sump) unglued. This allows him to remove it and clean roots from the drain tube with a plumber's snake.

Like most amateur hydroponicists, Herrington buys his nutrients ready-mixed. It's far easier, and usually the results are more precise than if you mix them yourself. And the nutrients aren't expensive. Paul Droll (Llord Laboratories, 347 Pippo Ave., Brentwood, Calif. 94513) sells Herring-

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ton his mixture for 90 cents a pound. That's enough for 100 gallons of nutrient solution.

Testing the pH

Since the feeding takes place automatically, about the most important attention Herrington must give his hydroponic garden is frequent testing of the nutrient's pH (acid/alkaline balance). Plants, whether in soil or hydroponic solution, are pretty perverse, in that they won't utilize available nutrients if the pH is too far from ideal. A slightly acid 6.5 pH (7 is neutral) is a general standard for growing multiple crops. If you're growing a single crop hydroponically you can tailor the pH of the solution exactly to that plant's needs. Droll recommends taking a pH test every day. But when Ken Herrington is away from home on a two-week photography assignment, this greenhouse goes unattended. "My pH generally goes up to 7.5 when I'm away that long," he reports, "but my plants always look fine."

He uses phosphoric acid to lower the pH. Sulfuric acid and oxalic acid are also used, and just plain distilled white vinegar is fine for the purpose. Typically, the hydrponic solution tends to wander too far toward alkalinity; but if it should get too acidic, you can raise the pH with baking soda.

As evaporation and transpiration deplete the water in the reservoirs, Herrington replaces it with plain fresh water. During the summer he adds water every two or three days, but during the winter months, only seldom. Both transpiration and growth rates are much slower then.

Every three weeks Herrington dumps his nutrient and mixes a fresh solution. "I just put a hose on my submersible pump and run the old nutrient outside to my fruit trees and grape vines," he explains. For elaborate commercial operations, experts like Droll contantly analyze the nutrient solution and add whatever elements are missing. That way the nutrient can be recycled much longer. But you have to have some pretty sophisticated equipment—and skill—to do it well.

Periodic sterilization of the growing beds is also necessary for the good health of a hydroponic garden. If the units are used only during the summer, the time to sterilize is before planting. In any all-year system, Droll recommends you sterilize annually or anytime you've had an infestation of pests

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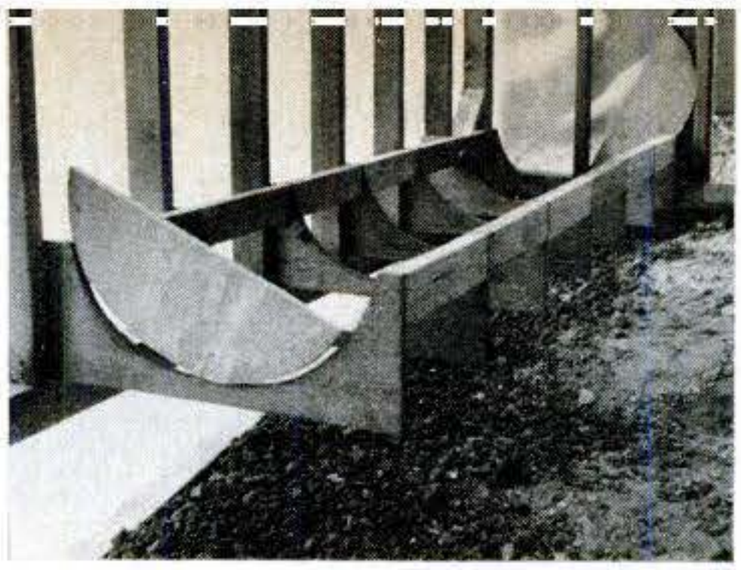
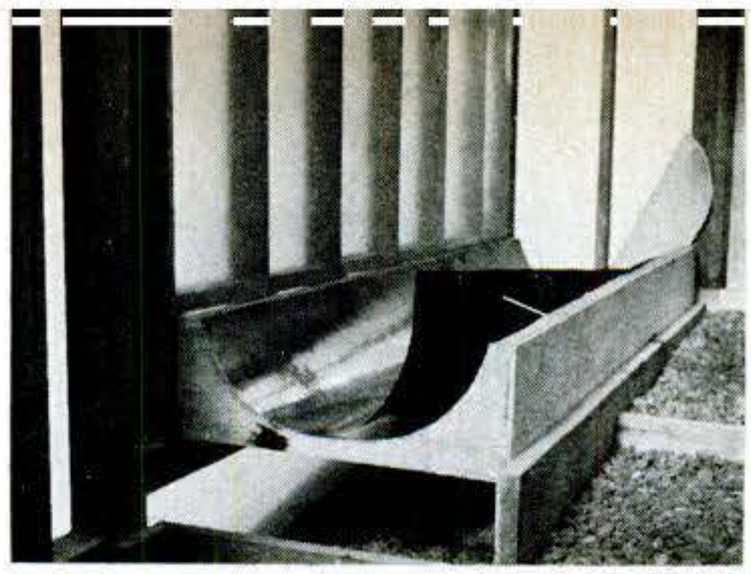
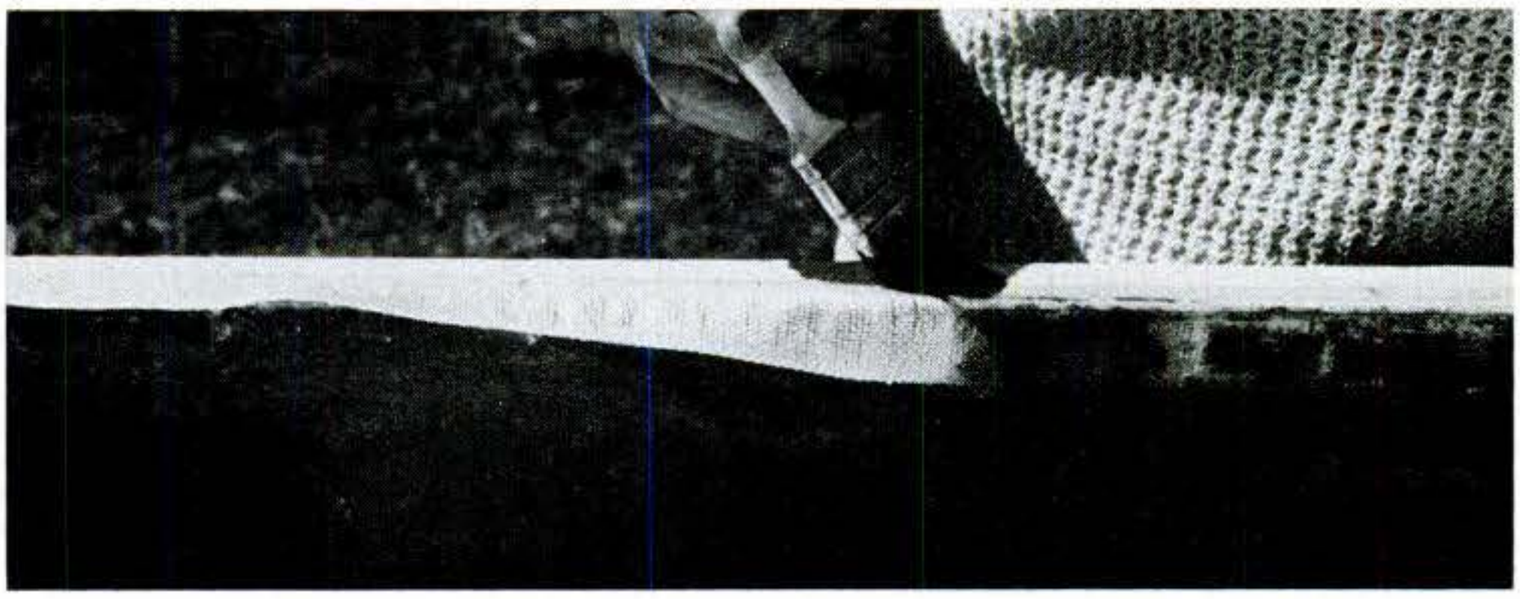


Two growing beds hang on south wall of greenhouse. Upper bed is 2′ by 8′ by 9″; lower is 2′ by 15′3″ by 9″. Supports are ¾″ ply cut as shown (on 16″ centers); 2-by-4's are nailed between.

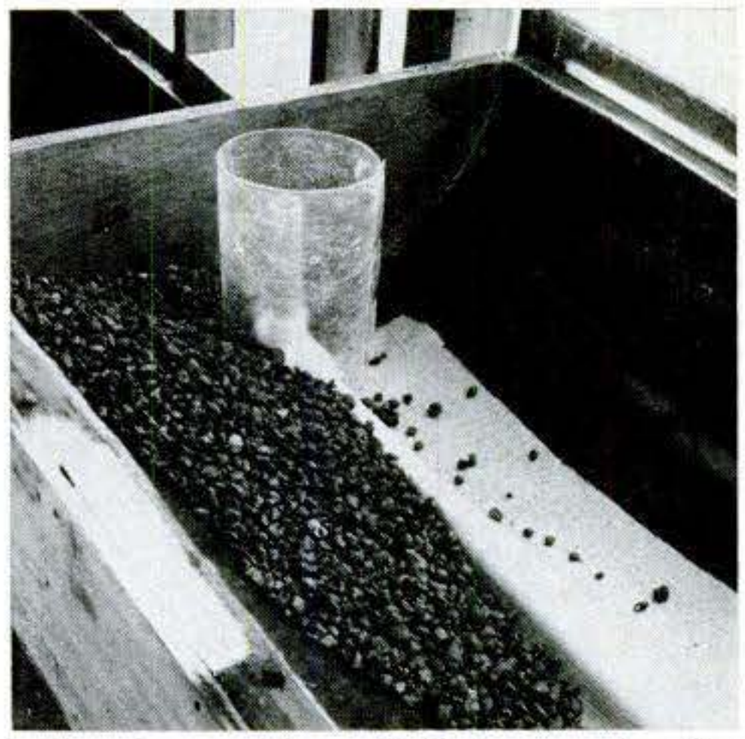


Five-oz. fiberglass, painted black on bottom to keep light from roots, is nailed to 2-by-4's on sides. Quarter-moons cut from supports are used as end pieces; ½″ ply covers outer side of beds.

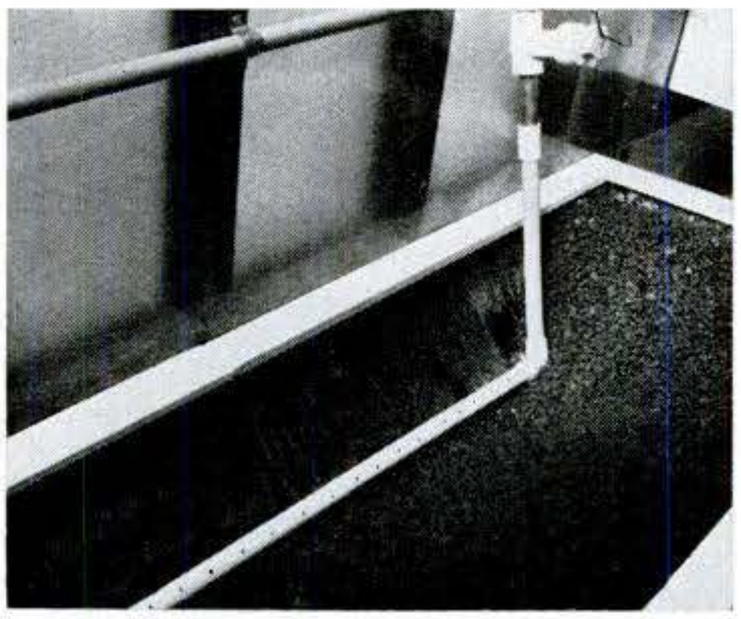


Sides are sealed with two-inch fiberglass tape and epoxy resin to cover crack between fiberglass and 2-by-4's. End joints are treated similarly.

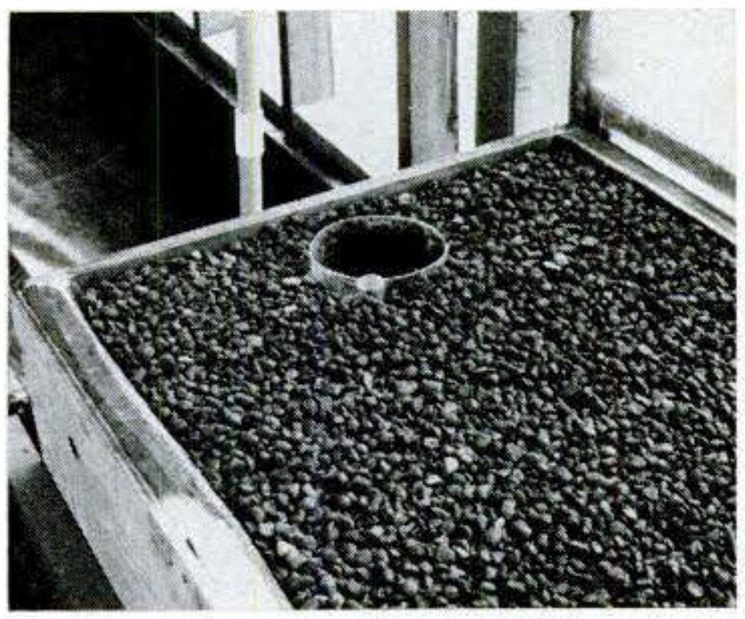
Drain tube has ⅛″ holes every six inches in bottom. Outlet hole is waterproofed with epoxy putty. Vertical overflow tube near end keeps nutrient solution an inch below top of aggregate.



Fiberglass collar with holes punched in it at appropriate level keeps aggregate from vertical overflow tube. Fiberglass cloth helps keep aggregate—and roots—out of holes in drain tube.



Filling tube has ⅛″ holes every 2½ inches. Holes are in this position only for photography; they'll be pointed downward for operation. This assures tank will fill at uniform rate.



Upper growing bed is ready for planting except for finish trim that will be put on sides of bed and a couple coats of paint. Note that top of overflow tube is well below surface of aggregate.

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Kitchen and workshop space savers— build roll-top cabinets

No-hinge cabinet doors offer greater safety and more storage and convenience

By THOMAS H. JONES

Most people don't have to walk into an open cabinet door more than once to wonder if there might be a better way. Sliding doors are a lot safer, but they limit access to the shelves. These cabinets avoid both problems by using tambour doors, which are installed after the frames are up. They make handsome space-saver cabinets for your work area or, with a better grade of lumber, for your kitchen. You're familiar with the principle from roll-top desks: Tambours are flexible panels sliding in grooves. Gluing slats on canvas may be monotonous, but that's all there is to making them.

The cabinet dimensions shown were chosen to make economical use of 4-by-8-foot plywood panels for the shelving. The cabinets can be made any length you want or with as many sections as you need. Two-by-three construction lumber is not my favorite cabinet material, but it was handy and the right size for the frames. Although ¼-inch plywood was used for end and partition panels, other thicknesses (or hardboard) will work as well. Plywood thinner than ¾-inch could be used for the shelves if it's stiffened front and back.

The tambour strips can be ripped from almost anything, ranging

Size and number of sections can vary to match counter in any shop or kitchen.

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from ⅜-inch plywood to pine or redwood—or you could use ¾-inch half-round molding, but it's costly.

Construction

Begin construction with the frames. Each is made of four pieces of 2x3 dadoed to receive a ¼-inch plywood panel. These panels form the ends and partitions of the cabinets and brace the frames so they won't sag. The panels on the side frames are spaced ¼ inch in from the outer edges, and the center frame panels are offset from the centerline so that the frame mounting bolts can be located closer to the centers of the rear 2x3 pieces.

The frames are assembled around the panels with butt joints reinforced with two dowels at each corner. Sand the frames and round the edges, particularly the bottom-front corners.

After assembly, slot the frames for the tambour track. The back track is stopped 18 inches down, but the front track is routed to the end so the dado can be used as a mortise for the bottom-front rail tenon.

The next job is to hang the frames temporarily for alignment. I used ⅜-inch lag bolts anchored in my basement walls by means of expansion shields—two to each frame. It's important to get the holes right so the frames are all precisely vertical, and aligned at the same height. If they're not, the roll-tops won't operate smoothly. You may have to shim at the back to compensate for an uneven wall.

To build the roll-top track assemblies that go on top of the frames, use 2x4's on edge, with ½-inch plywood and pine attached to the face(s). Assemble these parts with screws instead of nails and glue—the front track blocks must be removable for installation of the tam-

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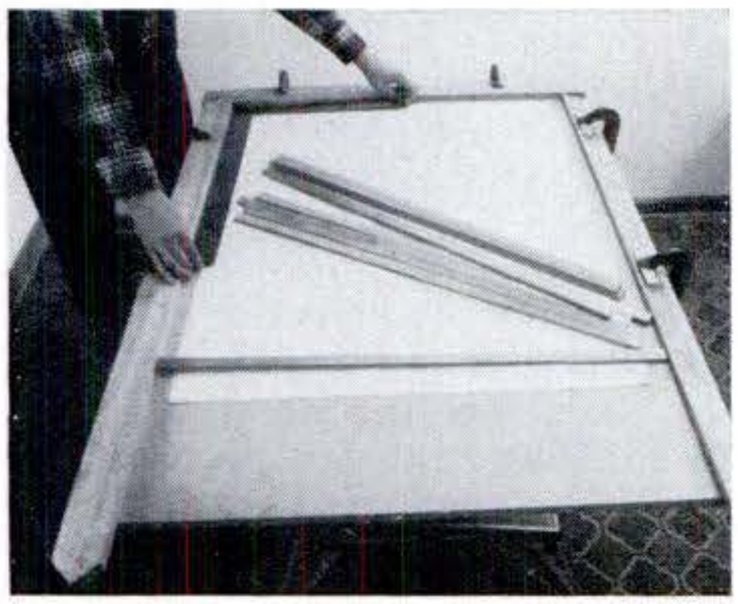
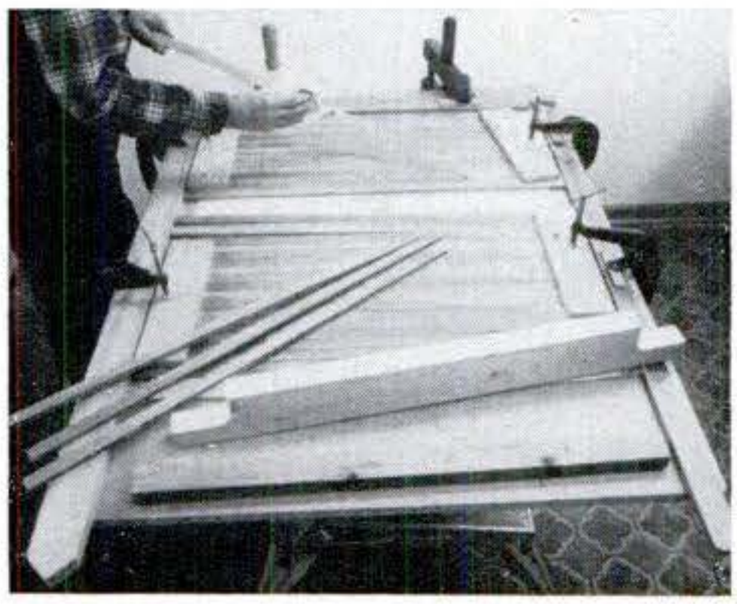
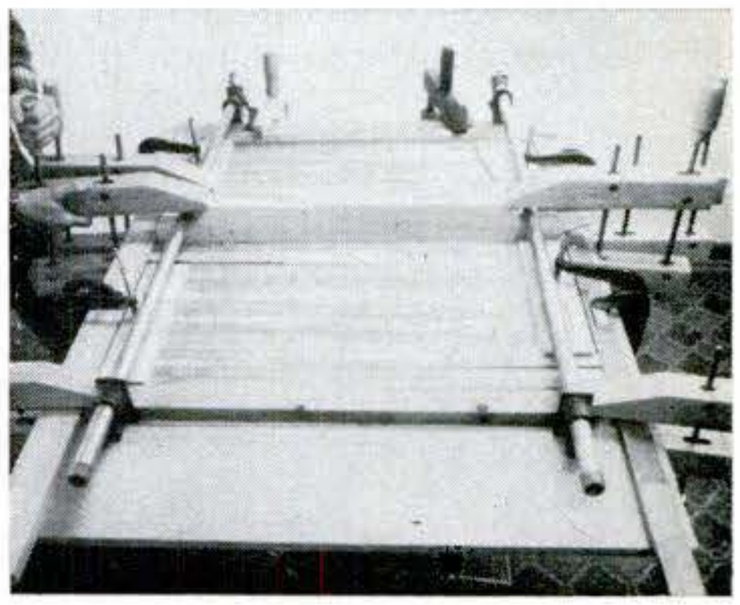


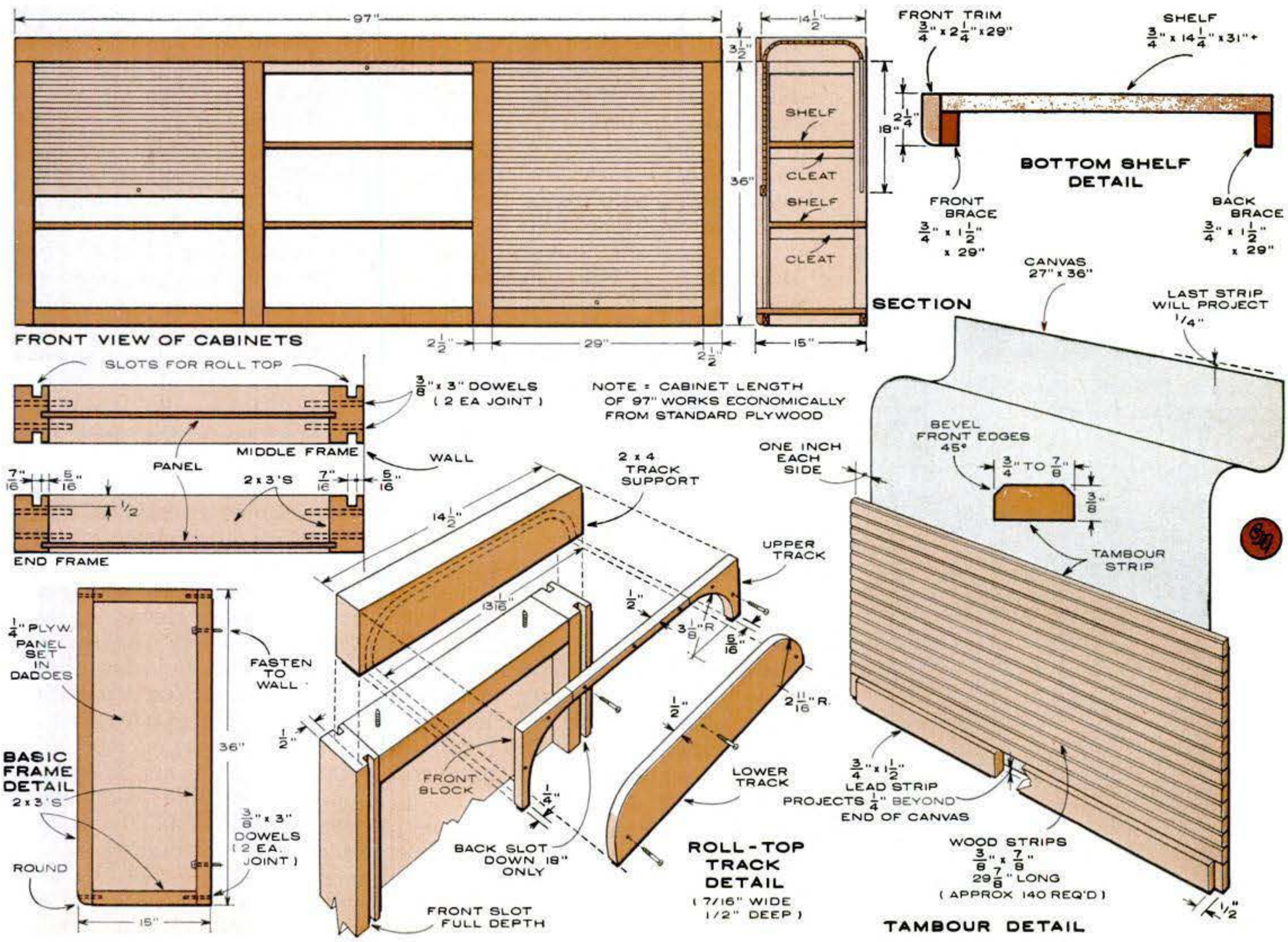
Square up guide frame and clamp to a flat work surface, with canvas centered.



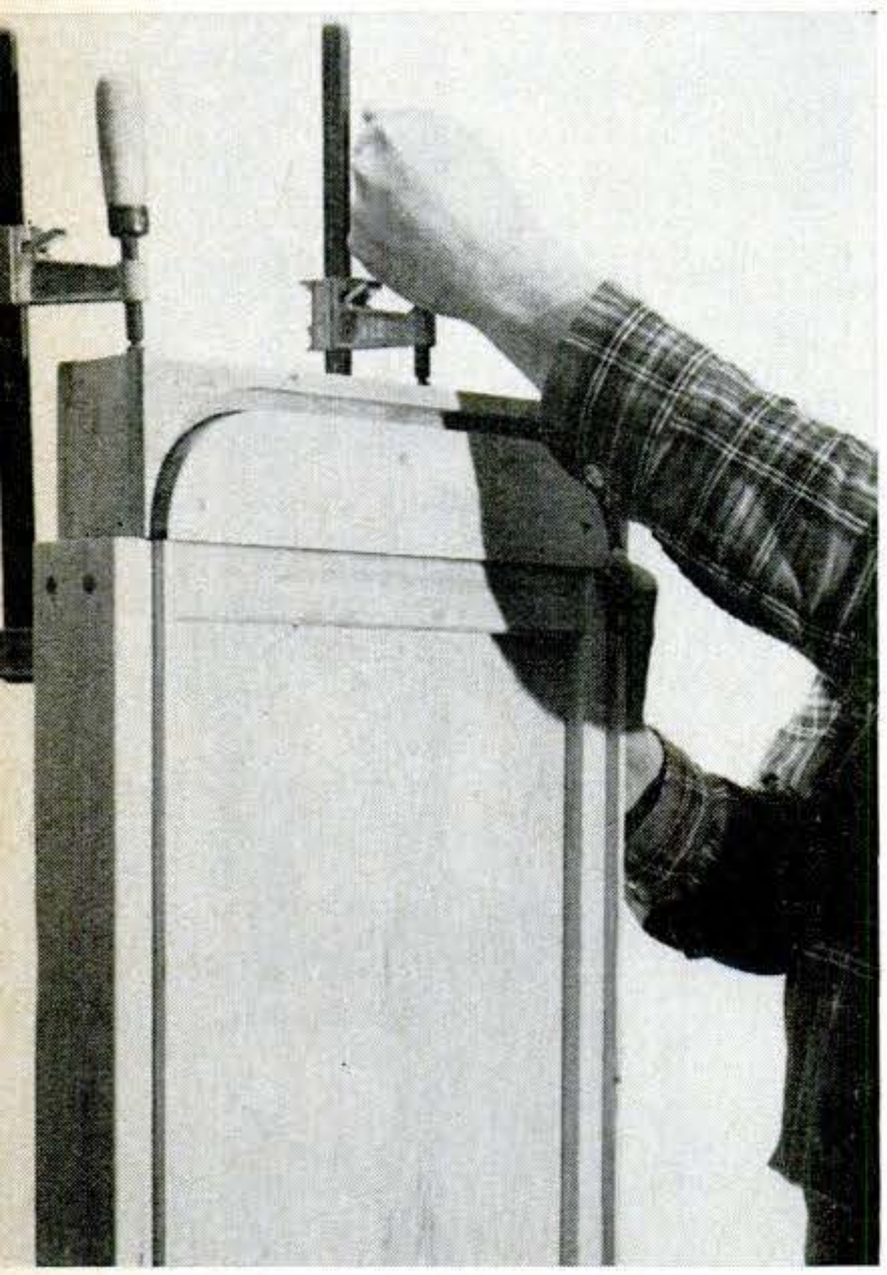
Apply thin, even bead of glue to each strip before clamping to canvas face.



Pipe clamps draw strips snug as glue sets. Center cleat supports pipes.



Lag bolts in expansion shields hold frames. Add shims to align as needed.



Attach header, aligning its track with grooves in frame. Join with screws.

Insert tambour after waxing grooves and slat ends. Replace track blocks.

bour doors, and the other pieces may have to be shifted to compensate for frame misalignment. Take the frames down one by one and attach the header assemblies with screws. Then permanently mount each frame.

Assemble the bottom-front rails and attach them between the frames with corner braces and wood screws, using their tenon ends and the track dadoes in the frames for positioning.

Cut the three bottom shelves and attach the back rails to them. (Note that the three shelves do not have the same dimensions.) These shelves rest on the bottom of the frames and front rail. Attach with screws.

Making the sliding doors

For the tambour slats, I used a sheet of ⅜-inch birch plywood, ripped in ⅞-inch-wide strips. Even if you choose to rip up solid lumber, you shouldn't have to worry about warping. If you lay out the strips so warps will oppose, there will be no warp after assembly.

After ripping all the strips, bevel the front edges slightly. Then sand and finish them completely—except on the backsides. Cut out and tenon the lead strips and finish them. For your work surface, use something flat, such as particle board (a flush door will do as well); clamp on a guide frame for assembling the roll-top, as shown in the photos. Be sure all sides of the frame are square, and cover the frame-in area with waxed paper so the canvas won't stick to the work surface if glue should seep through.

Cut a piece of lightweight canvas or duck, 28 by 36 inches, iron it to remove wrinkles, and glue the lead strip to one end. Clamp the lead strip against the front-edge frame, stretch out the canvas, and lay all the other strips in place. Clamp the strips down lightly so they can't buckle, and draw the strips together with a pair of bar or pipe clamps. Be sure the back edge of the last strip and the lead strip are parallel, and mark this position on each side frame.

Now release the clamps and, starting at the lead strip, apply a single bead of glue along the centerline of each strip and clamp it to the canvas. Using a 2x4 on edge as a clamping bar, you can glue two or more strips at a time, depending on how many clamps you have available. Each time before you clamp vertically retighten the bar clamps so the roll-top cannot drift out of square. Using white glue at a 70°F shop temperature, you can remove clamps for reuse every 30 minutes.

Finishing the job

Regardless of how you're going to finish the cabinet, varnish the grooves, sand, and wax them liberally. Do the same for the ends of the tambour strips. Remove the front track blocks to expose the top groove, roll each tambour with slats out, and feed slat ends into the tracks. They should go very easily. Replace the front blocks, position the tambour open with half of a strip (plus the lead strip) below the top of the frame, and screw stop blocks in each of the back tracks to support the top in this position. This is done to keep the lead strip from banging against the top trim every time you roll up the door (eventually causing it to tear loose). One centered knob on each door allows you to open it easily with one hand.

Unless you're bringing a suspended ceiling in to butt along the top of the cabinets—as I did—use ½-by-four-inch pine for a header. Attach it with screws, since you might have to remove it sometime (to get one of the roll-tops out). You can rest a wall angle for a suspended ceiling in the ½″ notch at the tops of the frames, with or without wood trim, and fasten it with screws to the track assemblies.

Finishing up, simply cut out the remaining plywood shelves and block them up on pieces of plywood pushed against the panels in the frames. If you want to change the shelf height, just cut new supports.

One strong suggestion: Put backs on the cabinets, at least behind the top shelf. If you don't, it's quite possible for a piece of stored material (like a paint can) to become lodged between the shelf and the space needed for the top of the roll-top when you try to open it. In the worst case, you'd have to slit the canvas to get the cabinet open.

The same tambour-cabinet design could be used for kitchen cabinets, or for cabinets anywhere else in the house. However, one additional change is necessary. When these doors start closing, they close—with a bang. You wouldn't want that to happen to a cabinet full of dishes or glassware. Add a spring restraint, which can be located behind the cabinet back and can function much like the springs on an overhead garage door. Use a long coil spring, set up so it is stretched only during the last few inches of door closing. PS

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PS PULL-OUT DATAPAGE

Silicone-rubber sealant —versatile "sticker" for your car

As it flows out of its tube or cartridge, silicone-rubber sealant is a smooth yet sticky material with the consistency of toothpaste. It air-cures overnight into tough, resilient silicone rubber that has astounding properties:

- It is virtually unaffected by temperature extremes from −65 to 450 degrees F.
- It will bond to almost any clean surface (except certain plastics).
- It is waterproof and is unaffected by weather or aging.
- It won't shrink, crack, or crumble when used as directed.

These features make silicone-rubber sealant ideal for dozens of common maintenance, repair, and customizing chores on your automobile. The suggestions below and those in our photographs are just a few of the possibilities. The more you use the stuff, the more applications you'll think of.

1). Consider silicone-rubber sealant as an all-purpose adhesive for use inside and outside your car, and under the hood. There are only two precautions: Don't use it where it will come in contact with gasoline, or the silicone will eventually soften and fail. And it may not stick to vinyl trim.

2). Use silicone rubber to weatherproof and seal body components. It makes a tough, flexible, virtually permanent seal that eliminates minor water and wind leaks. It's ideal for sealing a leaky windshield. And usually you can silence wind leaks in a door frame with a bead of rubber that seals the gap when the door is closed.

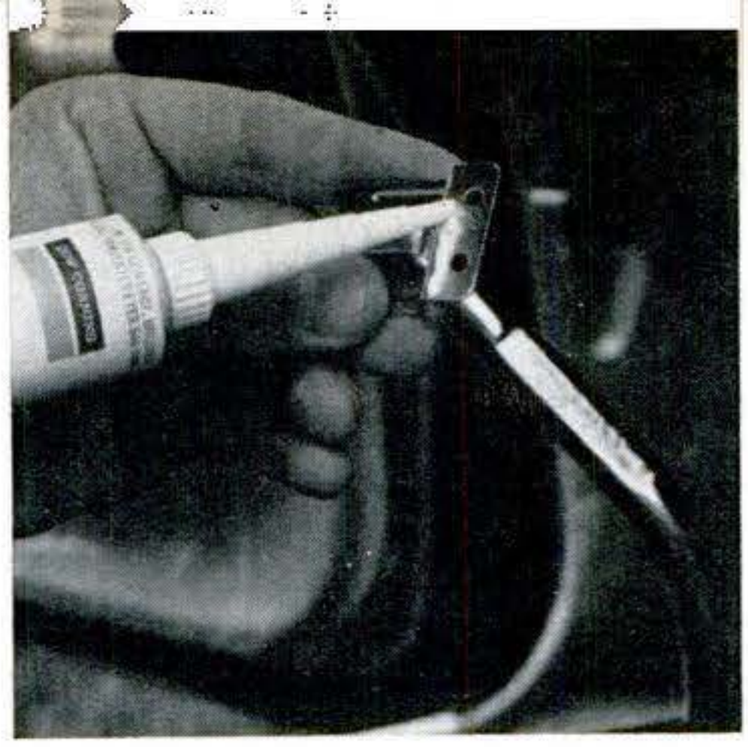
3). Use it to stop annoying rattles. Many are caused by loose metal parts that jiggle against other surfaces as the car moves. The lift-up load floor of a station wagon and the movable slide of a jack are two examples. You can usually quiet such rattles by building up "snubbers" of silicone rubber on the loose parts to prevent direct contact with other surfaces.

4). A dab of sealant will keep moisture and dirt out of the openings that allow wires to pass into an electrical connector. Similarly, you can encase a wire splice in a glob of silicone rubber to seal and protect it. The splice must be taped first because the sealant exudes a mild acid as it cures. Though harmless to most materials—including the wires' insulation—the acid can deteriorate the electrical properties of the conductor.

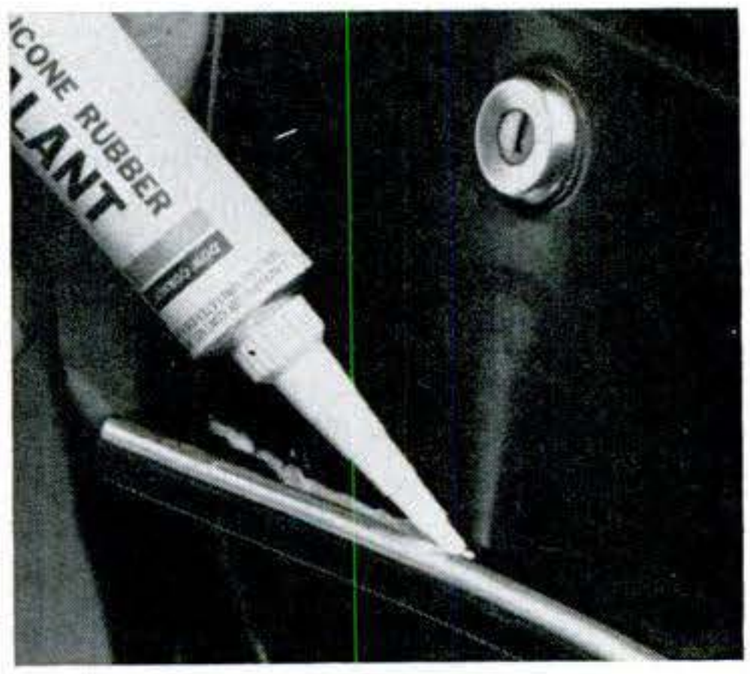
5). Silicone rubber can seal holes you've drilled to install accessories in your car (a tachometer, burglar alarm, driving lights, or a CB set, for example). Typically, these holes are in the fire wall, the rear wall of the trunk compartment, or the engine compartment's sheet metal. After you route the wires, fill the holes with blobs of sealant. Besides creating a waterproof seal, it will prevent the wires from chafing against the edges of the holes.

6). Use silicone sealant to make your own gaskets. [See "Gaskets You Squeeze from a Tube," PS, Jan. '75].

Silicone-rubber sealant is sold in tubes and in cartridges that fit caulking guns. Most hardware stores carry Dow and GE brands in four colors: clear, white, aluminum, and black. You'll probably also see silicone bathtub caulk on the shelf. This is essentially the same material, but with a fungicide to prevent mildew. You can use it in all of the applications we've listed.—*Richard Curwin* PS



Stick things to other things with silicone rubber sealant. Attach accessories, such as the mike clip for a citizens-band radio, to dashboard (left). Or secure a box of fuses inside the glove-compartment door (above).



Make repairs, inside and outside your car, with silicone sealant. Use it to stick back tears in fabric-backed door-panel covering (left) and to secure loose carpeting. Outside, use it to cement loose trim to body (right). Harsh conditions won't affect it.

Hide a spare car key in a cocoon of silicone rubber: Wrap key in aluminum foil, then find an out-of-sight location outside the car to hide the key. Clean surface down to the paint or bare metal, then seal the wrapped key in place with sealant. Road splatter will soon camouflage the package, but you can retrieve the key with a knife or a nail.

Rustproof metal body trim by running a thin bead of sealant in the tiny gap between the edge of the trim and the car's body. It will prevent moisture and road salt from reaching the mounting clips behind the trim.

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Car-care quiz

First in a series prepared for PS by NIASE (a non-profit corporation that tests and certifies mechanics) through the courtesy of Car Care Council

1 An engine is using too much oil. Mechanic A says that worn valve guides could be the cause. Mechanic B says that tapered cylinder walls could be the cause. Who could be right?

(A) A only
(B) B only
(C) Both A and B
(D) Neither A nor B

2 While the engine is running, a mechanic pulls the PCV (positive crankcase ventilation) valve out of its cover and puts his thumb over the valve opening. There are no changes in engine operation. Mechanic A says the PCV valve could be stuck in the open position. Mechanic B says the hose between the intake manifold (carburetor base) and the PCV valve could be plugged. Who's right?

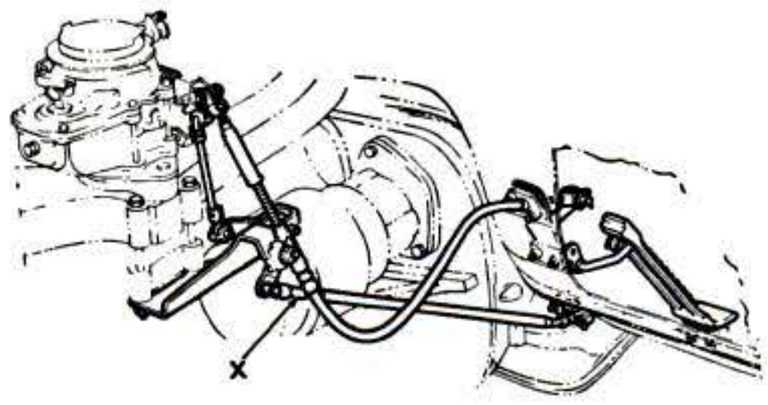
(A) A only
(B) B only
(C) Both A and B
(D) Neither A nor B

3 An engine starts but does not keep running when the ignition switch is in the run position. This problem could be caused by an open in the:

(A) Ignition resistor bypass circuit
(B) Ignition resistor or resistor wire
(C) Ignition-switch accessory circuit
(D) Starter solenoid

4 The exhaust-manifold heat-riser valve is stuck in the open position. Mechanic A says this can cause poor gas mileage. Mechanic B says this can cause the intake-manifold vacuum to be lower than normal. Can they both be right? If not, which one is?

(A) A only
(B) B only
(C) Both A and B
(D) Neither A nor B



5 Mechanic A says that if the rod shown above is disconnected at "X" the car will not downshift under heavy acceleration. Mechanic B takes a different view. He says that if the rod is disconnected as indicated the car will not upshift properly during normal driving. Who is right?

(A) A only
(B) B only
(C) Both A and B
(D) Neither A nor B

6 The steering wheel of a car is not centered when the car is traveling straight down the road. Mechanic A says that the steering wheel can be removed from the steering column and its position changed. Mechanic B says that the steering wheel can be turned to center and the toe-in readjusted. Who is right?

(A) A only
(B) B only
(C) Both A and B
(D) Neither A nor B

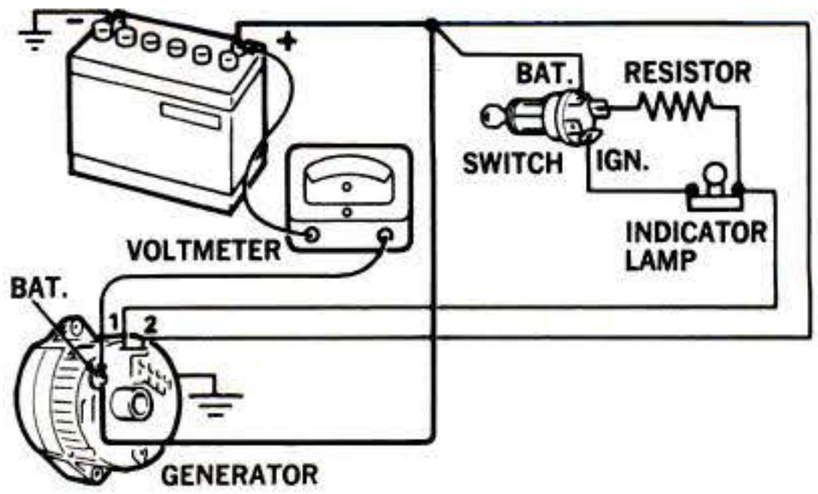
7 A hydraulic brake line is leaking. Which of these is the correct repair?

(A) Cut out the bad section and replace with new steel tubing using compression fittings
(B) Replace the line with double-flared seamless copper tubing
(C) Replace the bad section with single-flared steel tubing using flare nuts and unions
(D) Replace the defective line with double-flared steel tubing

8 The oil-pressure light stays on whenever the engine is running. The oil pressure has been checked and it meets specs. Mechanic A says that a ground in the circuit between the indicator light and the pressure switch could be the cause. Mechanic B says that an open in the pressure switch could be the cause. Who could be right?

(A) A only
(B) B only
(C) Both A and B
(D) Neither A nor B

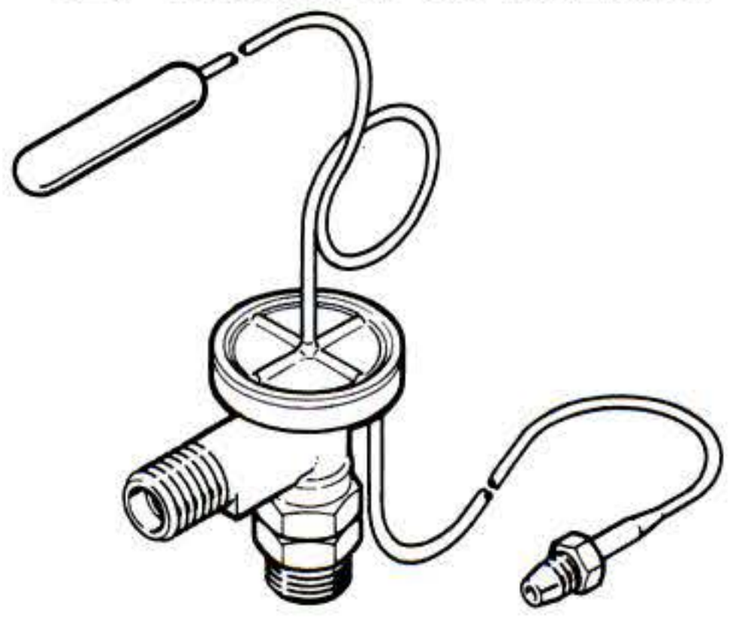
9 In the charging system shown here, the meter will show:



(A) Charging output voltage
(C) Indicator-lamp applied voltage
(C) Charging-circuit voltage drop
(D) Ignition-switch voltage drop

10 The main purpose of the A/C part below is to control the:

(A) Amount of R-12 that enters the evaporator
(B) Pressure of the evaporator
(C) Amount of R-12 that leaves the compressor
(D) Pressure of the condenser



Answers begin on page 114

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How to Achieve Total Financial Freedom in 1978

Millionaires Are Not 100 Times Smarter Than You, They Just Know The Wealth Formula.

" . . . more than 150,000 people have discovered that my formula will provide the road map that can lead to total financial freedom . . ."

We've never met and probably never will, but I think we share a common interest. That interest is in achieving complete and total financial freedom.

Because of this common interest, I think we can be of great help to each other. You see, a little over twelve months ago my net worth reached the magic million dollar mark, and it only took me 48 months to achieve that.

That might not impress you, but if you had seen me just a few years ago, you might wonder how I did it. I lived in Denver then, in a cramped, tumbled down house at 2545 South High Street. My wife was expecting our second child and we were so broke we had to borrow $150.00 from a relative just to buy food and pay the rent.

By the way, I know I didn't make a million dollars because of my superior intellect — I barely got through Ames High School (Ames, Iowa) with a C average. I did a little better later on but I soon realized that a salaried job was not the way to become financially free. If you'll stop and think, you'll realize that millionaires do not work 10, 20, or 50 times harder or longer than you.

Now, how can we help each other? I am willing to share everything I have learned and know that would help and guide you to achieve your own financial freedom and independence. But the only way I would ever give you my secrets, methods and formulas is if I benefit also.

You will find when you reach your ultimate financial goals, you really don't want to stop there but you are motivated to go on and make more.

It seems that most people who are charging for financial advice have studied how to "do it" but have never actually "done it" themselves.

You will find as you read my formulas, that since I have actually achieved total financial freedom myself, that you will receive from me more than just the motivation to achieve your own financial independence, but a workable step by step plan to actually do it.

You may have seen part of my formulas advertised in many publications, such as *Nations Business*, and the *Wall Street Journal*. This work is entitled **How To Wake Up The Financial Genius Inside You.** The various formulas contained in the volume will show you exactly how you can do each of the following:

- buy income properties for as little as $100 down.
- begin without any cash.
- put $10,000 cash and more in your pocket each time you buy (without selling property)
- compound your assets at 100% yearly.
- legally avoid paying federal or state income taxes.
- buy bargains at one-half the market value.

If you apply these formulas and methods you will find in a very short time, you will be able to spend three weeks out of every month doing anything you care to do.

I think, at that time, you will find as I have, that spending several weeks on the beaches of Hawaii, or on the ski slopes of Colorado, or just sightseeing in Europe, or any other place in the world, you begin to understand what real freedom is all about.

Most people think that it would be impossible to do some of the things listed above. For example, to buy a property, and at the same time put $10,000 (or more) cash in your pocket without selling the property, or to buy a property with little or no cash down.

Believe me, it is possible and fairly simple. This is exactly how most wealthy people actually do make 10, 20, or 50 times more money than you do.

These formulas of mine do not have to be used with income properties only. They actually can be applied to virtually any asset.

While I was struggling on making my first million, I often thought how nice it would be to have the personal advice and counsel from someone like Howard Hughes or J. Paul Getty.

What would I have been willing to pay for this service? I can tell you one thing for sure, it would have been a lot more than the $10.00 that I'm going to ask you to invest in your financial future.

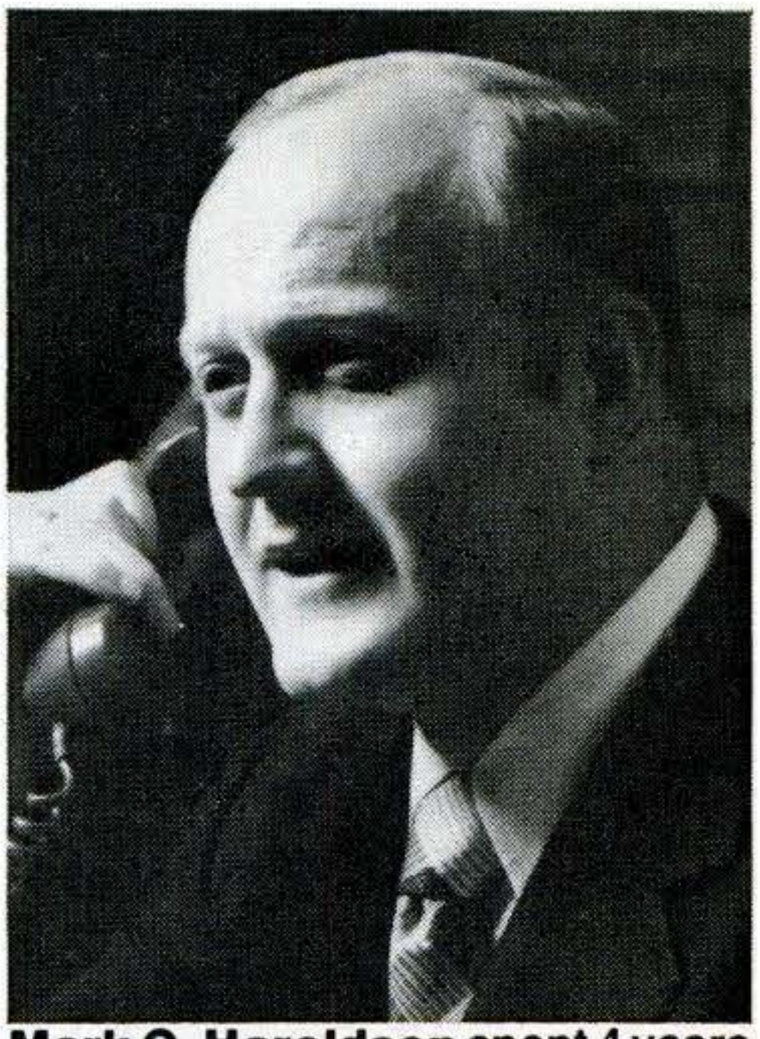
What will this $10.00 actually do for you? It will give you a complete step-by-step plan that you can follow to become totally and completely financially independent.

Please try to understand my dilemma. I'm not a New York advertising agency, with all their professional skill and manpower to write a powerful and persuasive ad to convince you that I can make you financially independent. I am just somebody who has actually "done it", and can really show you how to "do it".

What would you do, if you were in my shoes. You have in excess of $1,000,000 net worth, you have a desire to share your formula with others, because you not only have a simple, honest and workable method whereby others too can enjoy the riches of this land, but you also want to benefit and make money from sharing this information, so you can continue to grow financially.

I think you might do what I'm doing — that is to write a simple open letter to the type of people who share similiar goals as mine asking them to try the formulas for themselves, to see if they work as well as the claims described. Because, I know, as you would know if you were in my shoes, that if I can just convince you to test my formulas and methods, you will see for yourself that they will work as easily for you as they did for me.

It's really quite frustrating to have something so valuable as I know I have, but lack the skill to convince people to try it for themselves. I hope by my simple, direct approach, I can convince you to try my formulas.



Mark O. Haroldsen spent 4 years perfecting a "wealth formula" and became a millionaire in the process.

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Mark O. Haroldsen

P.S. If you are still somewhat skeptical, and believe me, when I started out I certainly was, because of the many people in the world trying to deceive others. I would encourage you to postdate your check by 30 days, and I promise and guarantee that it will not be deposited for at least those 30 days, and if for any reason you do not think that what I have sent you lives up, in every aspect to what I told you in this letter, send the material back, and I will quickly, without question, refund your money and send back your own uncashed check or money order. Also, if you would like to check a few of my references, I have listed some below.

The Salt Lake Chamber of Commerce, 19 E. 200 South, Salt Lake City, Utah 84111

Charles Huber, C.P.A., 1850 Beneficial Life Towers, Salt Lake City, Utah 801-531-8286.

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Inquire at your local bookstore for Mark Haroldsen's "How to Wake Up the Financial Genius Inside You."

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Car-care quiz **answers**

1 Mechanic A's diagnosis is correct. Valve guides are lubricated by the splash-oil method. A small valve-guide-to-valve-stem clearance is always maintained to allow for heat expansion and for oil to travel in and lubricate the moving stem. If this clearance becomes too great it allows excessive amounts of oil to enter the cylinder-head valve ports. In the case of an intake valve, the incoming air/fuel mixture is under a vacuum which tends to pull the oil into the combustion chamber and burns it.

Mechanic B's diagnosis is also correct. Excessive taper of the cylinder walls causes the piston rings to expand and contract every time the pistons travel up and down. This tends to reduce the rings' ability to scrape the oil film off the cylinder walls, allowing the oil to be burned with the air/fuel mixture.

The correct answer to this question is C.

2 The purpose of the PCV valve is to regulate the amount of crankcase vapors entering the intake manifold. The procedure described in the question is a simple test used to check for obstructions in the PCV valve, hose, and/or fittings. In a properly operating PCV system, engine rpm's will drop whenever the PCV valve opening is covered. If the engine speed fails to drop, the system is blocked or badly restricted.

Mechanic A's explanation of the test results is wrong. A PCV valve that is stuck open would cause no restriction.

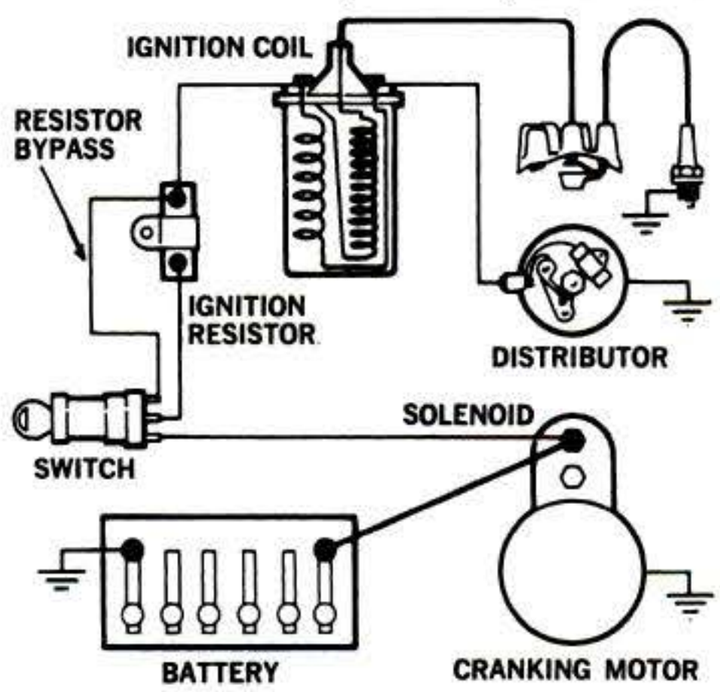
Mechanic B's explanation of the test results is correct. The test indicates a blocked system. A plugged PCV system connecting hose could be the problem along with any other system obstruction that would stop crankcase vapor flow.

3 Most automobile ignition systems have two paths for electrical flow to the coil. When the ignition switch is in the start position, full battery voltage is provided to the coil. This increases coil output and improves starting. When the switch is in the run position, current is redirected through a resistor reducing circuit operating voltage and increasing contact-point life without jeopardizing system performance.

Option (B) is correct. An open resistor would break the electrical flow to the coil, preventing system operation.

Option (A) is wrong. The resistor bypass circuit is not operational when the ignition switch is in the run position.

Option (C) is wrong. The accessory circuit is not directly related to the ignition-system operating circuit, and an open in that circuit will not affect system operations.



Option (D) is wrong. An open in the starter solenoid may prevent starter operation but does not affect the ignition system.

4 The purpose of the exhaust-manifold heat-riser assembly is to redirect exhaust gases during engine warmup through a special passage located below the intake passages in the intake manifold. This increases heat and aids the mixing of the air and fuel in the engine intake system.

Mechanic A's statement is correct. When the valve is stuck open, no exhaust gas is redirected. This condition increases the intake system warm-up time, which lowers efficiency and reduces gas mileage.

Mechanic B's statement is wrong. The manifold heat-riser valve and passages are not connected directly to the intake-manifold passages. Failure in the heat-riser system will have little effect on vacuum.

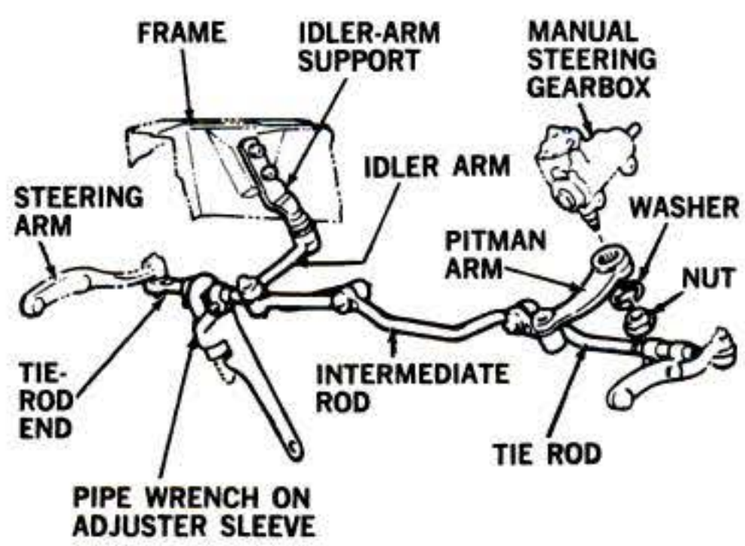
5 The throttle-linkage rod connects the carburetor to the automatic-transmission throttle and kickdown valves. The rod's position affects transmission throttle pressure. This pressure, along with governor pressure, is used in controlling transmission shift points.

Mechanic A's statement is correct. If the rod is disconnected, no movement of the kickdown valve will take place and the transmission will not downshift.

Mechanic B's statement is also correct. If the rod is disconnected, the throttle value will not change position and the throttle pressure will remain the same, resulting in erratic or no shifting.

The right answer is (C).

6 Mechanic A's repair is wrong. Steering-gear boxes are designed to be centered when the steering wheel is in the straight-ahead position. This allows proper gearbox operation and the front wheels to turn equally in both directions. By removing the steering wheel and repositioning it on the column the mechanic misaligns the box and wheel, causing the box to operate off center and reducing equal turning of the front wheels.



Mechanic B's repair is correct. To center a steering wheel properly, the gearbox should be positioned

Continued

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SURE YOU WANT TO KEEP YOUR CAR LONGER. BUT DO YOU KNOW HOW TO?

It's a lot easier than you think to help make your car last. For instance, make sure it's kept well tuned. Have maintenance check-ups performed when your owner's manual tells you to.

And be very careful about the motor oil and filters you use. Because they both protect your car's engine.

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in the middle of its travel with the steering wheel located in the straight-ahead position. Then the front wheels should be adjusted to the straight-ahead position with the proper amount of toe-in.

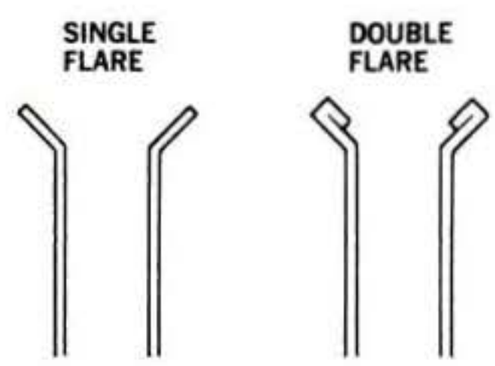
7 The steel tubing, fittings, flexible hoses, and seals that make up the hydraulic-brake-application system must be able to withstand high operating pressures.

Option (D) is the correct repair. A leaky brake line should be replaced with new steel tubing that has double flared ends. The double-flared end prevents the flared area from splitting and provides a good seal.

Option (A) is wrong. Compression fittings do not provide the high-pressure sealing required by the system.

Option (B) is wrong. Copper tubing is soft and can fail under high pressures.

Option (C) is wrong. Single-flared steel tubing does not provide the sealing integrity needed by the system.

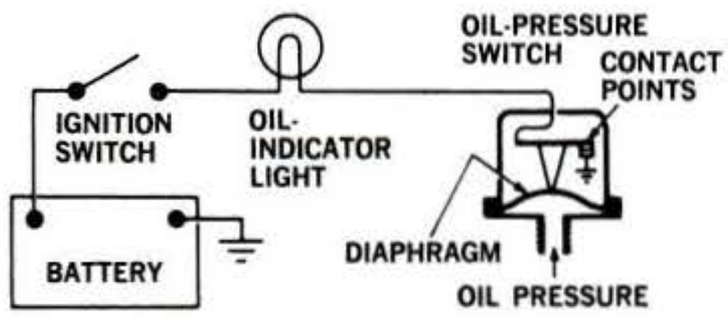


8 The contact points in the oil-pressure switch shown in the circuit below provide a path to ground whenever the oil pressure is not high enough to push the diaphragm up and open the contacts.

Mechanic A's statement is correct. A ground anywhere in the circuit between the light and the switch would complete the circuit and turn on the light.

Mechanic B's statement is wrong. An open in the switch would prevent completion of the circuit at any time. This condition would never allow light operation.

The answer to this question is A.



OIL-PRESSURE INDICATOR LIGHT CIRCUIT

9 When a voltmeter is connected between a power supply and ground, it will read the available voltage (voltage delivered by the power source). When a voltmeter is connected between a circuit component and ground, it will read the applied voltage (actual voltage at a given point in a circuit). When a voltmeter is connected between two points in the same circuit, it will read the voltage drop (voltage lost or used up in that portion of the circuit).

Option (C) is correct. The voltmeter is connected at either end of the charging circuit, therefore it will read the voltage drop caused by the resistance of the wires and connections in the circuit.

For option (A), the voltmeter would have to be connected between the alternator battery terminal and ground.

For option (B), the voltmeter would have to be connected between the switch side of the lamp terminal and ground.

For option (D), the voltmeter should be connected between the ignition switch terminals.

10 The refrigerant (R-12) in an A/C system absorbs heat while in the evaporator and gives off heat while in the condenser. The amount of R-12 entering the evaporator varies in accordance with system demands. The thermostatic expansion valve (the component shown on page 112) provides this control.

Option (A) is correct. The expansion valve controls the amount of R-12 entering the evaporator and at the same time drops the pressure of the R-12.

Option (B) is wrong. Although evaporator pressure may be affected by the expansion-valve operation, it is not its main purpose.

Option (C) is wrong. Expansion-valve operation will have little effect on the amount of R-12 leaving the compressor.

Option (D) is wrong. The expansion-valve operation will have little effect on the pressure of the condenser. PS

QUICK-CHECK KEY

1.C	6.B
2.B	7.D
3.B	8.A
4.A	9.C
5.C	10.A

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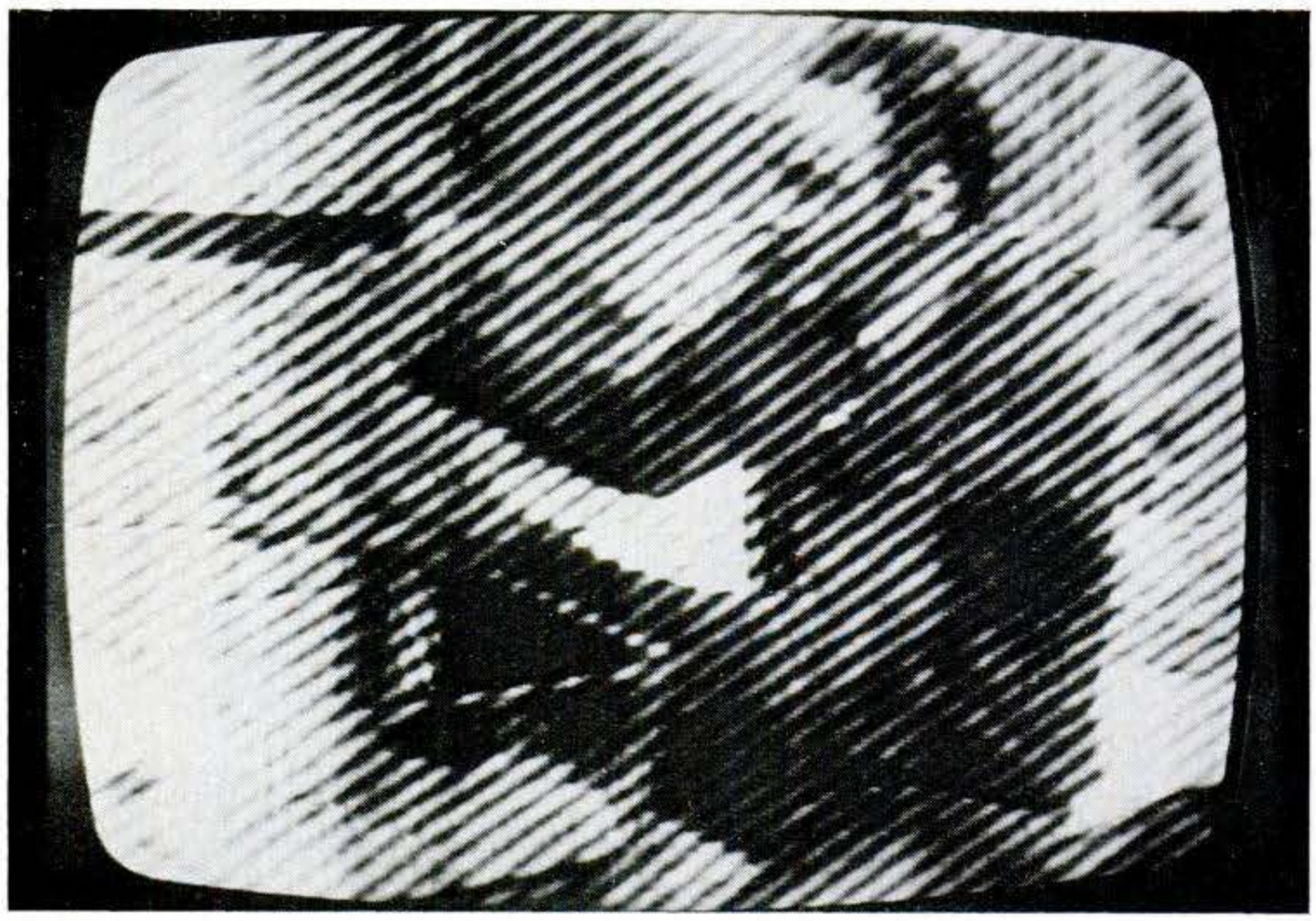
At your rig or at your TV curb CB interference

Simple TV and CB fixes remove TVI

By LARRY KAHANER



Wavy herringbone pattern is TVI—television interference from CB harmonics.

If "Soap" suddenly turns to soup on your TV screen, or Wonder Woman begins to talk in a deep voice about Smokey on the greenstamp, you've got TVI trouble.

TVI—television interference—can plague your TV with everything from wavy lines to a complete loss of picture and sound. Although it can be caused by any kind of outside transmission interference (ham radio, cabs, police, etc.), CB radio has become the prime target of prime TV watchers—and for good reason. Last year alone, the FCC logged over 85,000 complaints attributable to CB transceivers, though not all directly related to TV reception: CB transmissions can creep into your hi-fi, electronic organ, phonograph, PA system, or any other type of home-entertainment equipment as well.

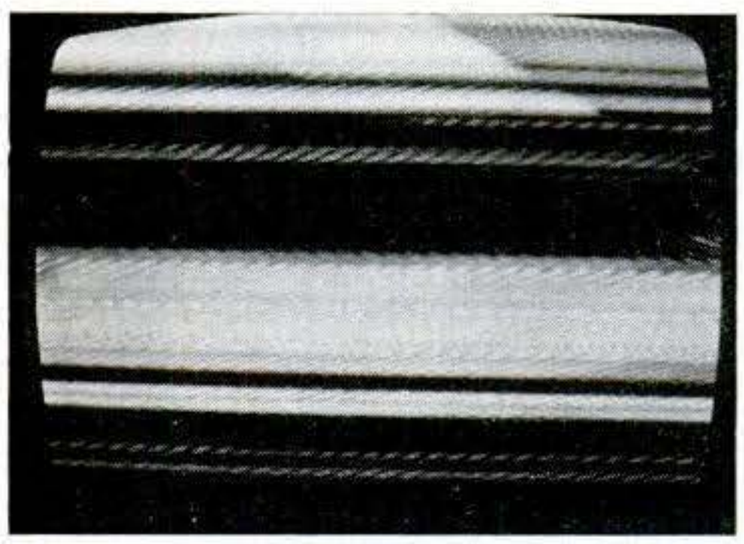
While avid TV watchers are quick to put the blame on a local CB'er and vice versa, fact is the problem—and the solution—is at both ends of the transmitted signal. Here's what can be done at each.

At the CB set

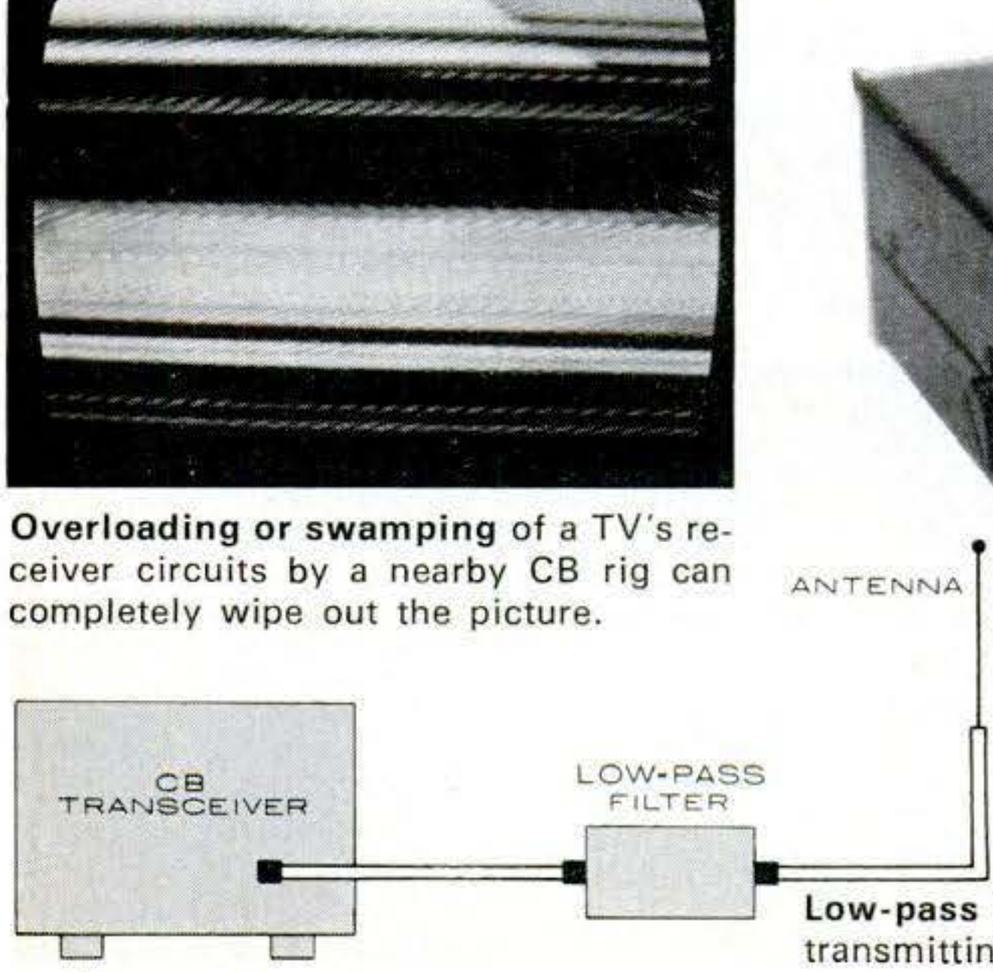
Over 90 percent of all interference is caused by harmonic radiation and overloading.

All transmitters send out harmonics—unwanted signals that are multiples of their operating frequency. Since CB radios operate on a frequency of 27 MHz, their second harmonic is at 54 MHz, third harmonic at 81 MHz, and so on. Unfortunately, TV stations use

Continued



Overloading or swamping of a TV's receiver circuits by a nearby CB rig can completely wipe out the picture.



Low-pass filter between the CB rig and transmitting antenna (sketch at left) will suppress the harmonic signals that cause interference in TV and other systems.

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Meet Ernest Borgnine, the famous stamp collector.

50th Anniversary Year of Talking Pictures (Oct. 7, 1977)

Surrender at Saratoga 1777 by Trumbull

US Bicentennial 13 cents

Surrender at Saratoga (Oct. 18, 1977)

Everyone knows Ernest Borgnine, the famous actor. But did you know he collects stamps? Off the screen, it's one of his most interesting and rewarding activities

Stamp collecting can give you that same kind of enjoyment. And U.S. Commemorative stamps are an easy, affordable way to start building your collection.

Through the years, Commemorative stamps have shown the history and people who have helped make America, America. And you can buy them right at your local Post Office. New Commemoratives are issued every few weeks. (There's even a guidebook called *Stamps & Stories* to tell you how to get started.)

Start collecting now, with the 50th Anniversary Year of Talking Pictures and the Surrender at Saratoga Commemoratives. You'll be building a collection you and your family will treasure for years.

As Ernest Borgnine says, "I hope that someday my children will enjoy stamp collecting as much as I do."

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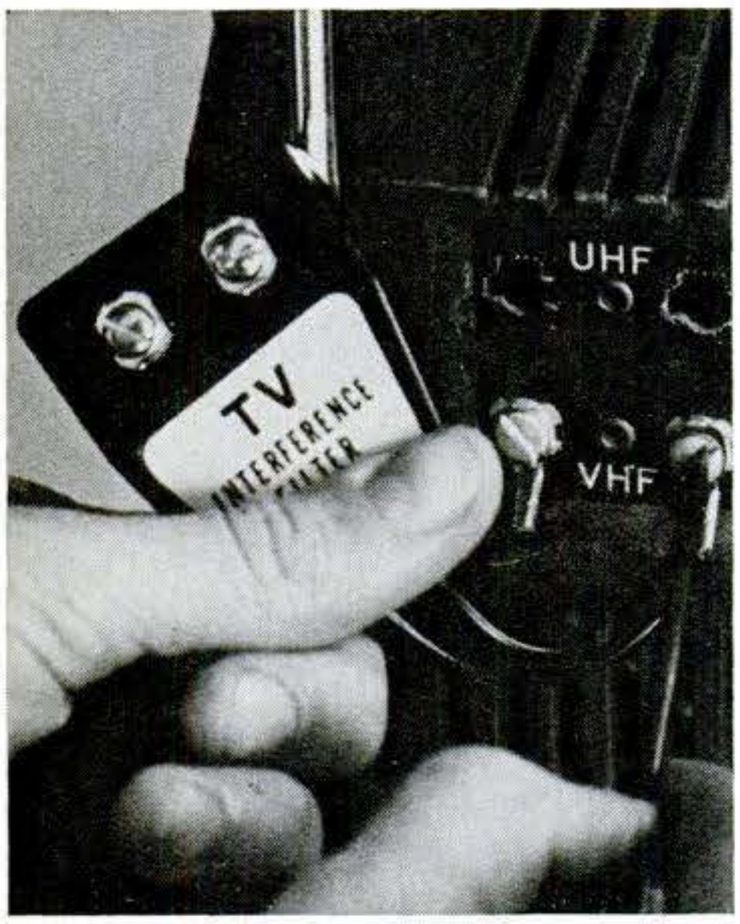
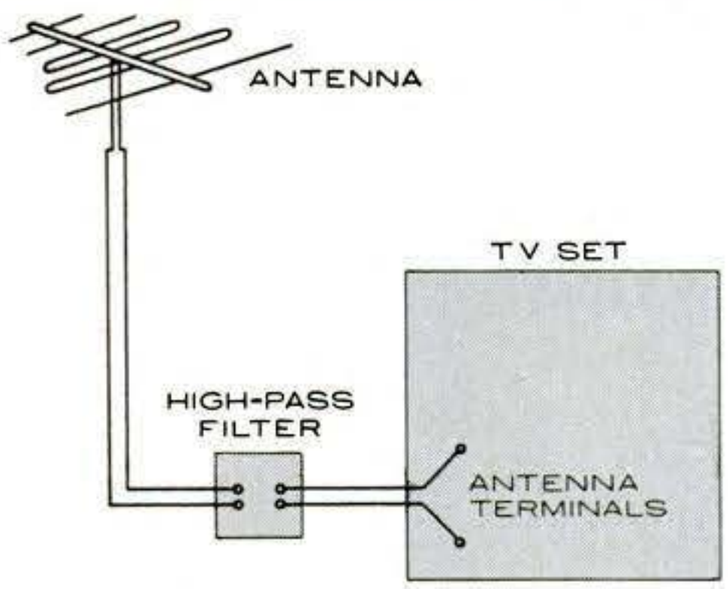
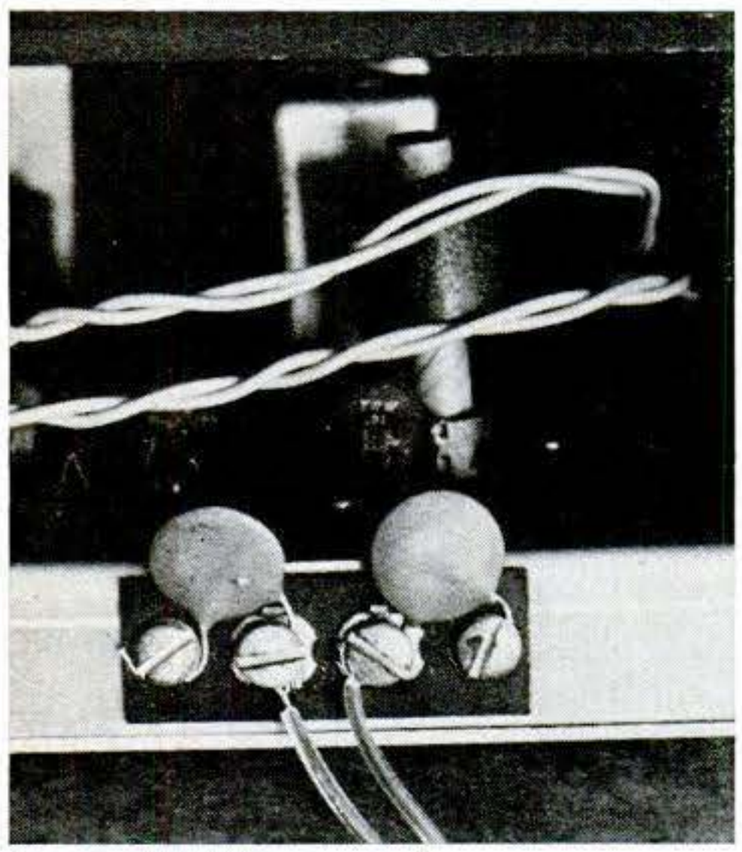
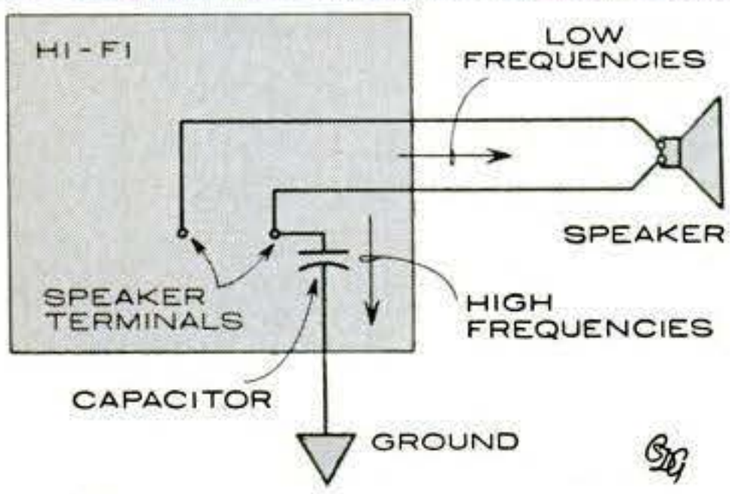




High-pass filter goes between TV and antenna lead-in. Wire it as close to TV terminals as possible.





Adding capacitors to the speaker connections of an amplifier prevents signals from entering through cable.

these frequencies, too, and if the CB harmonics are strong enough you'll receive them on your TV set. Channel 2 (54-60 MHz) and channel 5 (76-82 MHz) are most prone to harmonic interference, which shows up on your screen as wavy lines, sometimes called herringbones. This is usually accompanied by audio interference (you can hear the CB'er as well), but not always.

Harmonic interference can only be decreased at the CB'er's end—at the transceiver. And, by law, harmonic suppression is the CB'er's responsibility. It can be accomplished just by placing a low-pass filter in the antenna transmission line (see photo and diagram). Low-pass filters (as their name implies) only pass frequencies lower than their predetermined cut-off frequency. CB low-pass filters normally pass frequencies below 35 MHz, allowing the 27 MHz to reach the antenna, but cutting off the 54 MHz and higher harmonic frequencies.

At the TV set

The other interference cause is overloading or "swamping." The transmitter's signal, because of its proximity to the TV, overloads the TV's receiving circuitry and prevents normal TV signals from getting through. The result is dark horizontal bars on the TV screen with accompanying audio interference; in severe cases, the entire screen goes black. Overloading affects all channels, but may taper off slightly as you tune from channel 2 to 13.

Television sets possess little protection (called selectivity) from such overloading. Even though your TV should only receive signals at about 54 MHz, any frequency from a strong nearby transmitter can also get through.

TV owners must bear the burden for overloading interference, since technically it is their receivers that are deficient in screening out legal frequencies. The cure, however, is simple and inexpensive.

To prevent overloading, install a high-pass filter between the antenna lead-in wire and the TV antenna terminals. If your set uses rabbit ears, the filter goes between the TV antenna terminals and the wires to the rabbit ears.

High-pass filters work just the opposite of low-pass filters. They only allow signals higher than their cut-off frequency to pass through. While the 54 MHz signal is allowed to reach the TV receiver, anything below 45 MHz—which includes the 27 MHz CB band—is cut off. These filters are inexpensive and should not spoil normal reception quality. They're available at most electronic supply stores.

Some TV manufacturers supply high-pass filters free of charge to set owners. Contact your manufacturer, tell him your problem and your set's model and serial number, and request a high-pass filter.

More problems, more fixes

While filters are great for blocking signals that come in through the antenna, sometimes overloading transmissions creep through the AC power line. To check if that's the case, disconnect the antenna. If you can still detect interference, then an AC line filter should be used between the power plug and wall outlet. AC power-line interference is also common in devices other than TV's: Hi-fi, organs, PA systems, and other interference-prone devices can be helped by installing an AC filter.

Audio appliances, however, can also be troubled by speaker-wire penetration: A long lead connecting the speaker to an amplifier system acts as an antenna to receive CB calls. Cures are easy, though. Simply place a 0.01 to 0.03 mfd disk capacitor at each speaker terminal. Connect one capacitor end to ground (normally the chassis) and the other end to the terminal. (Use a separate capacitor for each channel—on a stereo amplifier.) These capacitors act as high-pass filters, shunting the high-frequency CB signals to ground. Low-frequency music and voice signals pass unaffected to the speakers.

In the most severe cases of interference, it's necessary to bypass the first audio stage of any device (including TV's) with a 100-to-250-pf capacitor. But this procedure is tricky and, unless you've had experience with such things, you might want to call in a technician to do the work.

More you can do

Naturally, one of the main reasons for TVI problems is that CB and TV antennas are simply too close together. Move them as far apart as possible. Also, use shielded cable for your TV antenna lead-in wire. PS

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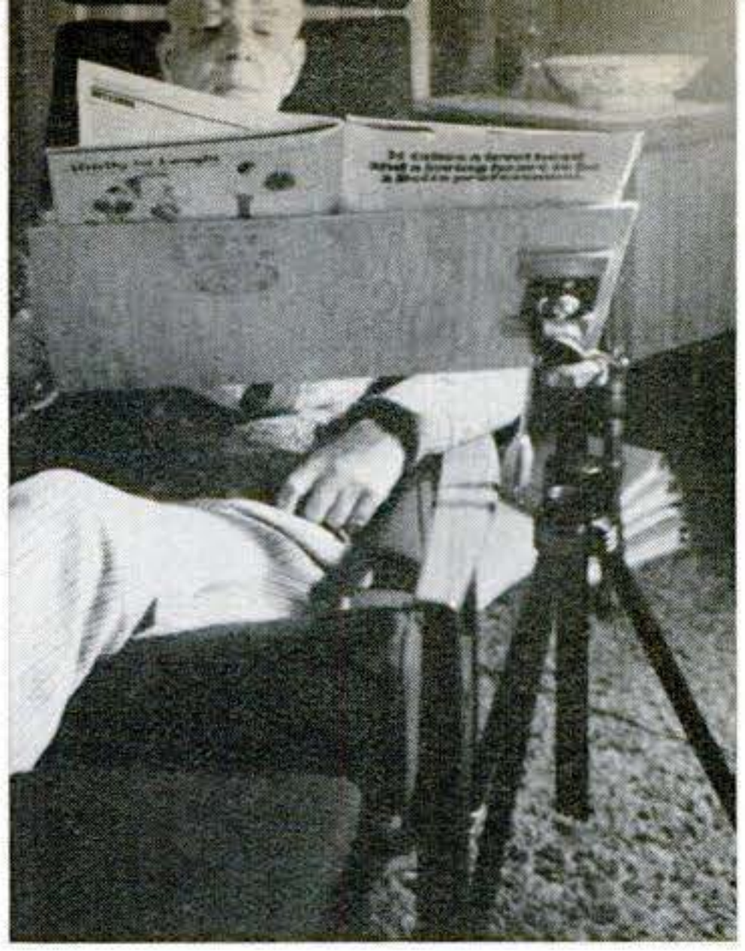
Emergency-light stand

Get ready for the next blackout—convert an old gooseneck lamp into an emergency-light holder. The flexible stand lets you direct a flashlight or lantern beam where it's most needed. To hold a tubular flashlight (lower right), attach a broom clip to an aluminum strip with a ¼″ x 20 wing nut, then bolt the strip to the gooseneck. To set up a lantern (top right), shape a piece of wood to fit inside the handle, then glue a ⅛″ hardboard flange (see kitchen photo) to one side of the cutout. Use a 3/16″ bolt and wing nut to attach the handle cutout to the aluminum fastening strip. To prevent scratches on the lantern, wrap the strip with electrical tape.—*W. Waggoner*



Tripod reading stand

Turn your camera tripod into a book easel. Just bolt a 10-by-20-inch panel of ¼″ plywood to the tripod's bed plate. For a book rest, glue a 10-inch-long cleat to the panel's bottom front. Attach two small cleats to the panel's back, above and below the tripod plate, to keep the stand horizontal. Now, just raise, lower, and tilt the stand to the easiest reading position.—*E. Daggett*

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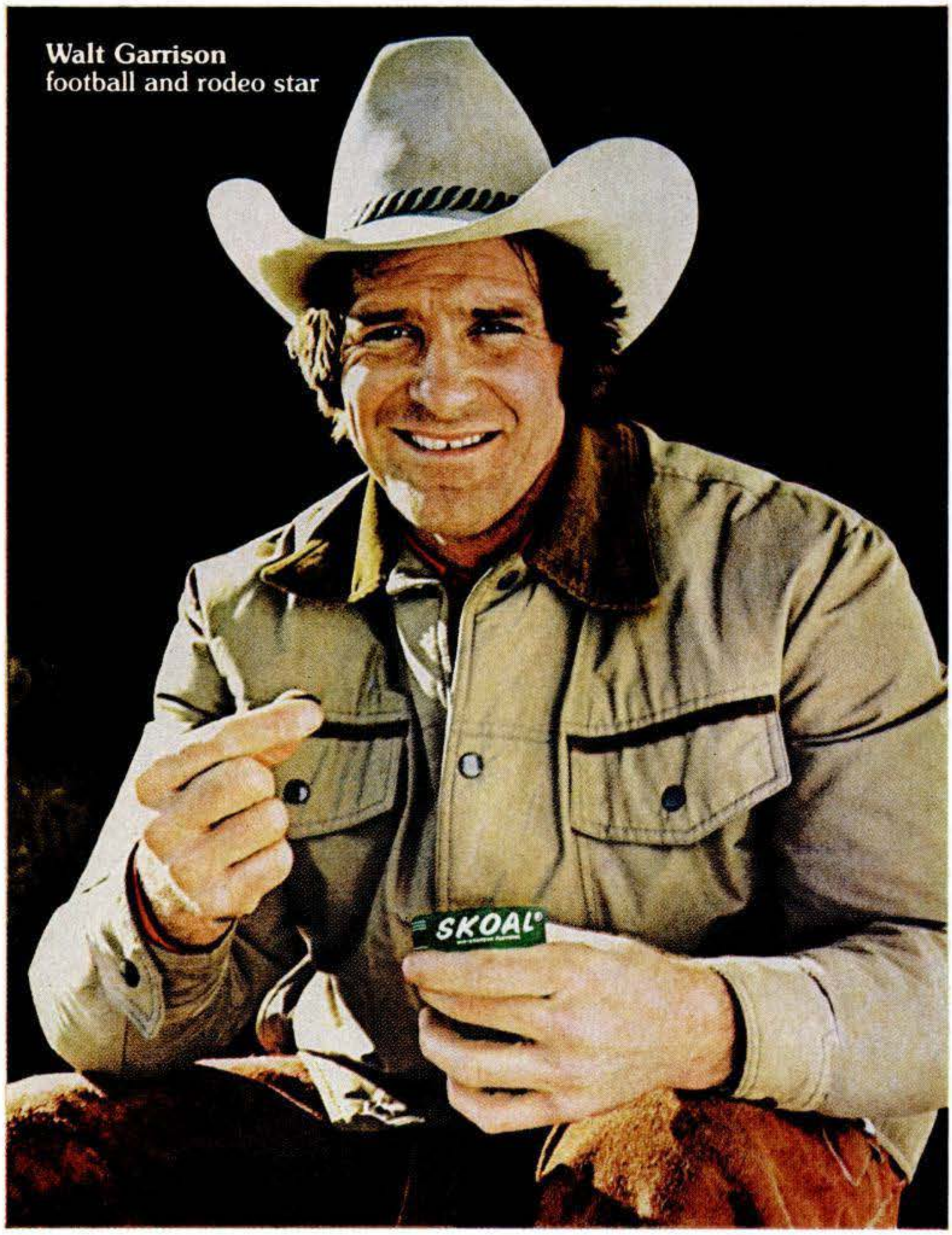

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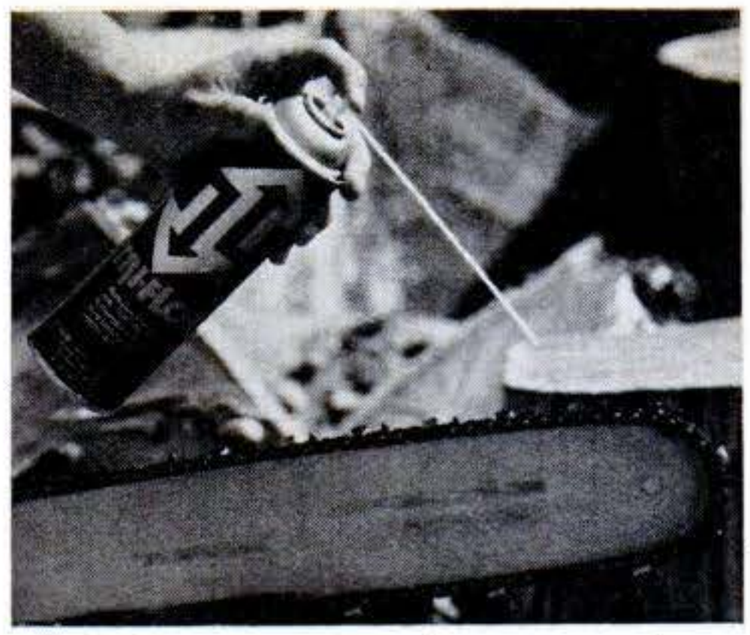

Oil-less chain-sawing
with a spray-on lubricant

Chain and bar oil for chainsaws is no longer necessary. Leave your oil reservoir empty. Yes, empty. Instead, spray on Tri-Flon—right along the bar at the base of the chain—claims the manufacturer. One Tri-Flon can (450 grams, $5.95, aerosol), it's claimed, replaces up to 22 quarts of bar/chain lube, for savings of more than $20.

A relatively new lubricant, Tri-Flon uses micron-size Teflon particles, which act as tiny bearings on the lubricated surface. Dust, sand, and other foreign particles are not held in suspension, but are rejected, preventing packing or clogging. Temperature stability is excellent: two-percent loss of efficiency per hour at 800° F. Operating range is very wide: −65° to 475°.

I tested Tri-Flon on a burred bar and an old chain. It lived up to the manufacturer's claims. I took down some large birch and cut fireplace logs. One application of Tri-Flon nearly carried me through a tank of fuel (beyond recommendations), and the bar and chain ran almost like new. Before the spraying with Tri-Flon, this saw, though powerful, could barely pull the chain/bar combo through thin, dry pine.

Next, I had a friend use Tri-Flon. He used it on a Homelite Super EZ with an oversized bar. His response after working with green maple and oak: "I don't believe it."

Because Tri-Flon rejects foreign particles, a possible problem arises. An old chain will need adjustment after about 15 minutes to compensate for the greater slack. And don't run chainsaws with automatic oilers totally dry—it could damage the oiler pump. Turn the oil supply down as far as it will go, and then use Tri-Flon.

Also useful as a general home and shop lubricant, it's made by the Tri-Flon Company, 3180 Pullman Street, Costa Mesa, Calif. 92626.—*Charles Self*

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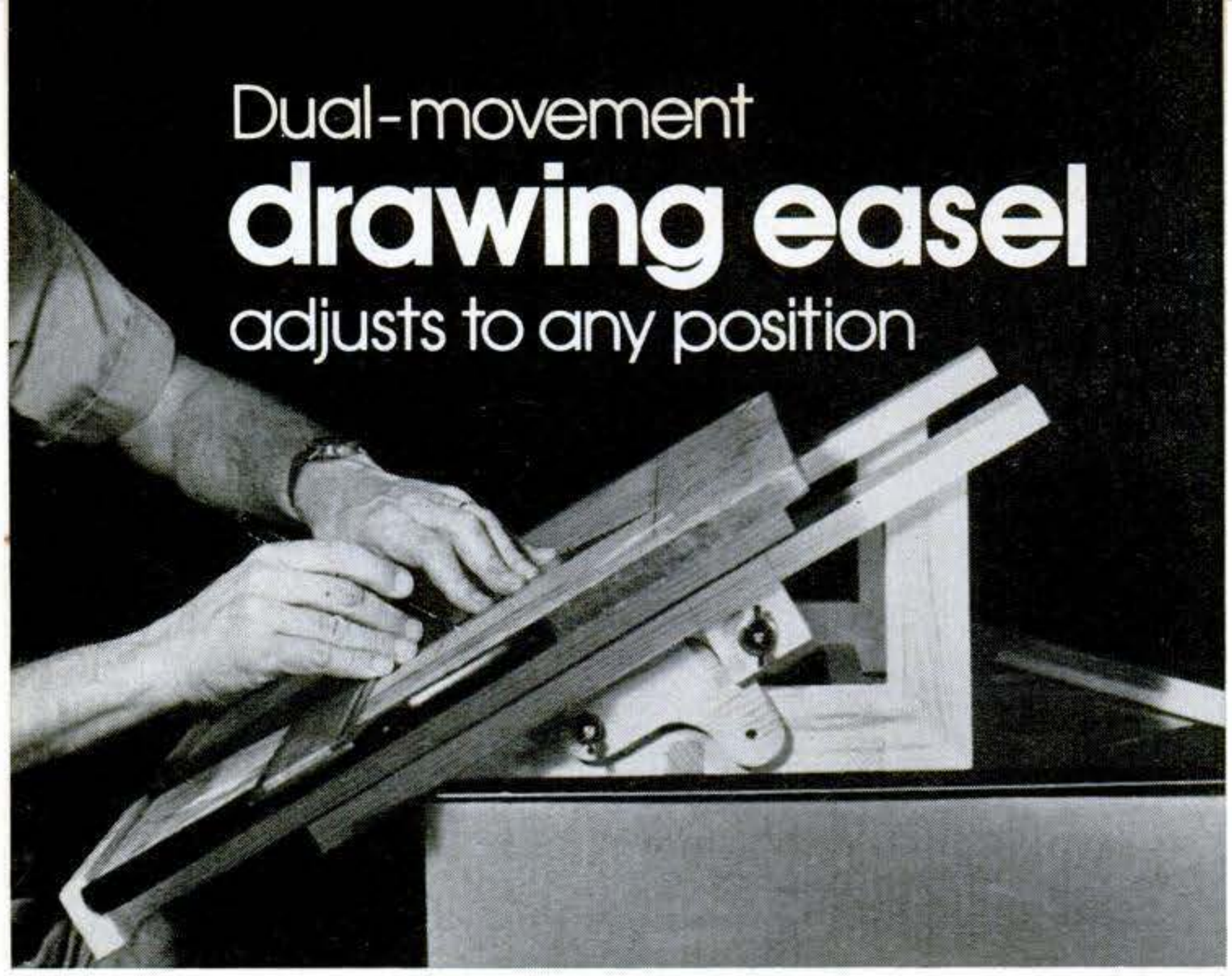
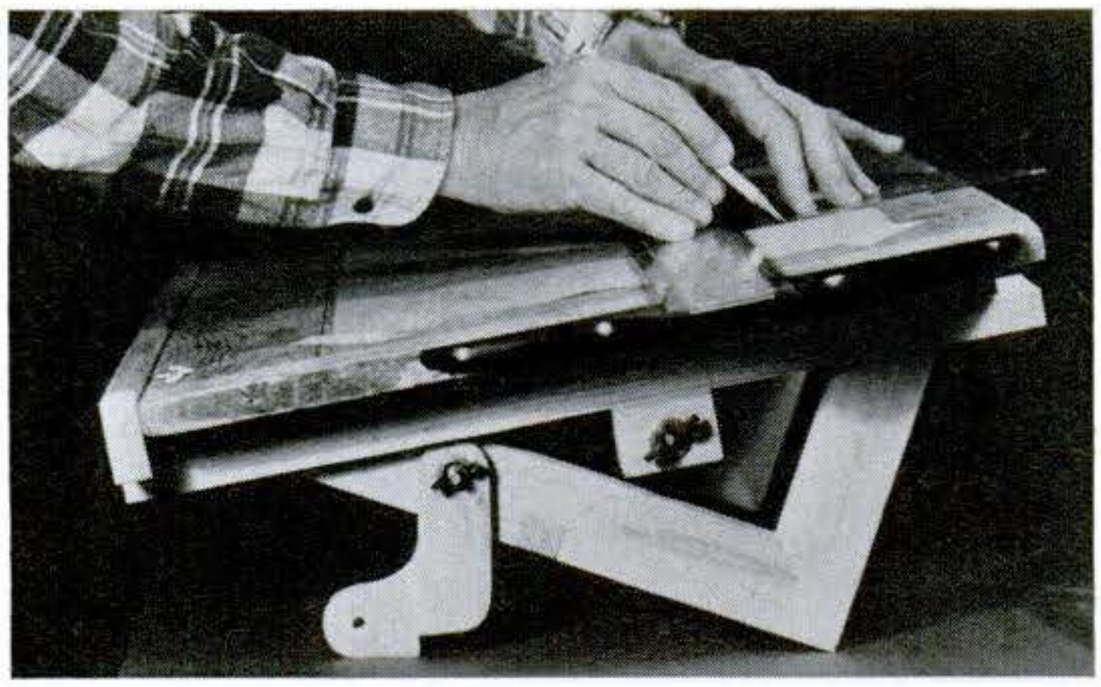
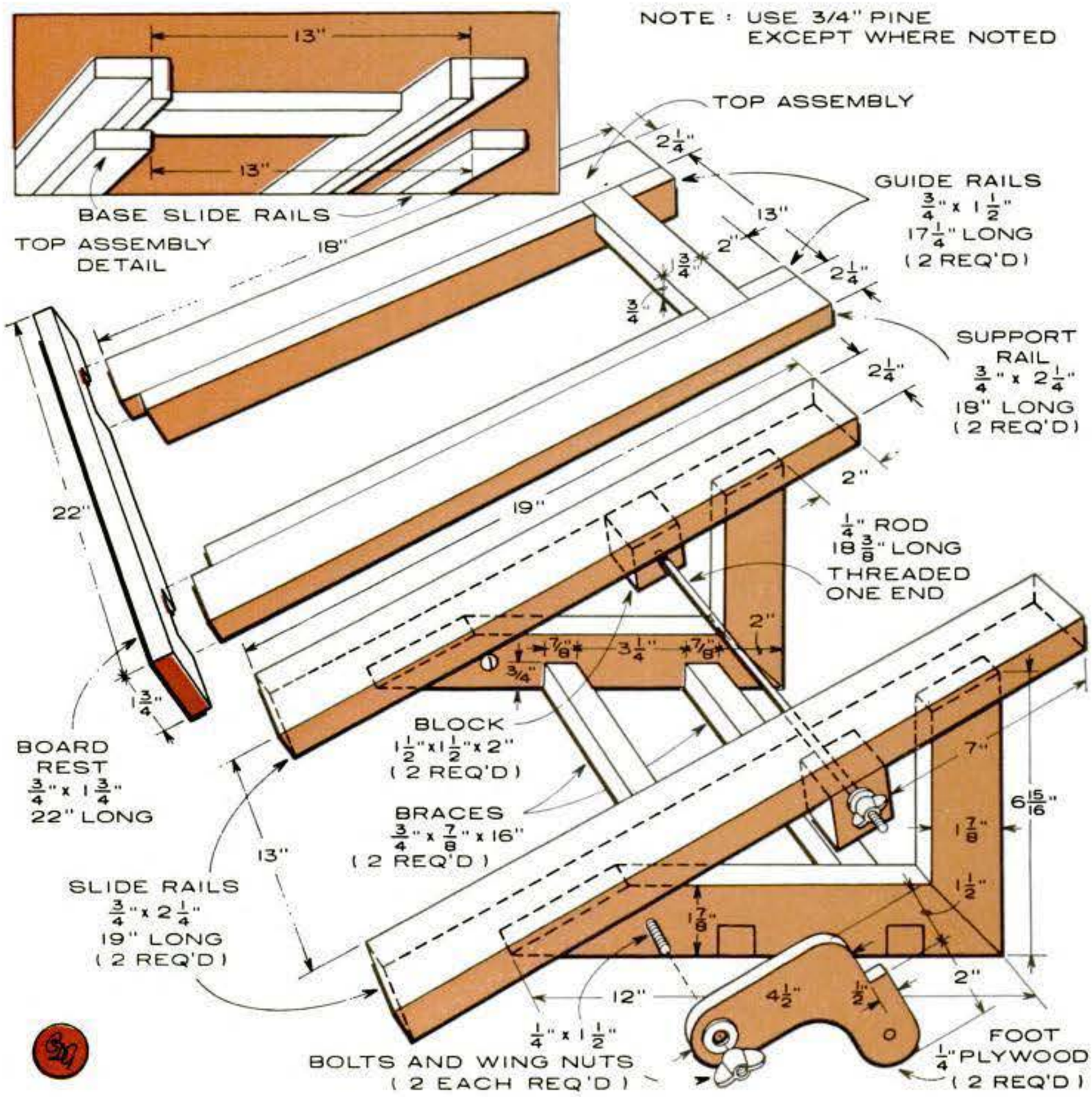
Dual-movement drawing easel adjusts to any position



Easel slides down for comfortable drawing at desk (above). Push board to top of track and easel can rest on your lap. Tilt the easel back to best angle for use at a workbench (right). Asymmetric feet adjust the tilt—stand them on end, turn them over, or rest on heels or toes to change the angle.





By ROBERT C. BARNES

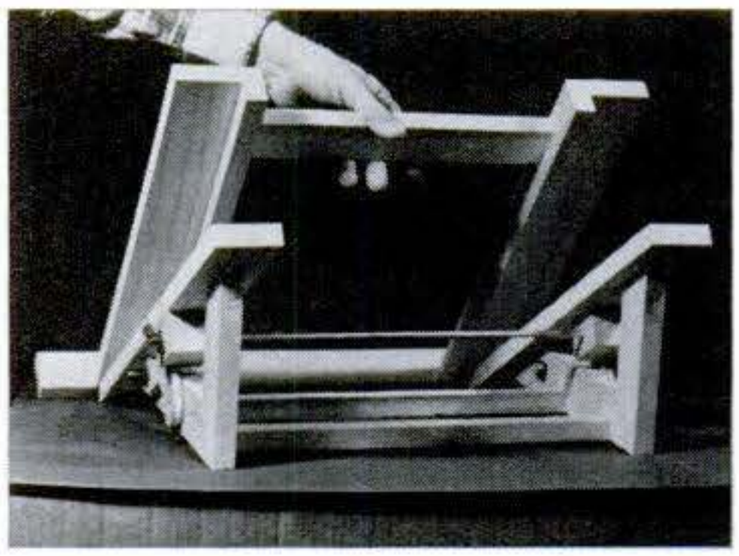
Set up this portable easel wherever you need to use a drawing board: You can sit at a desk, perch on a workbench stool, or even do out-of-doors drawing with the easel on your lap. The easel's two-part construction lets you adjust it to the position most comfortable for you. The top assembly slides up and down, and the base can be tilted to many different angles.

The easel shown in the diagram at left will accommodate an 18-by-24-inch drawing board. If you need a larger board, adjust dimensions to fit. In any case, use a 12-inch, 30-60° drafting triangle as the pattern for the easel's base.

The flanges of the top frame should fit snugly over the base sliding rails, so the frame can be moved up and down. To lock the top in position, turn the wing nut on one end of the threaded rod. This tightens the base against the frame, clamping it in place. Construct this clamp by gluing, then screwing, two blocks to the underside of the slide rails. Drill holes for the rod through the blocks' centers and drill a hole for a cotter key through one end of the rod. Pass the rod through the blocks and insert the cotter key as a stop.

The two plywood feet adjust the angle of tilt. Wing nuts on 1/4-inch bolts hold the feet at any angle you want. Be sure to make the feet to the dimensions given—their shape is what makes the variety of tilt positions possible. When you don't need them, swing the feet up against the rod supports.

Finish the easel with a coat of sealer. When dry, prop up your drawing board anywhere you need it. If you're also a photo buff, you can use the frame as a slide sorter. Tack on a sheet of 1/8-inch white translucent acrylic plastic, and set up a light behind it. PS



Back view shows two parts of easel. Base rails are spaced so top can slide up and down on them; rod and wing nut clamp rails against top to hold in place.

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Annie Crawford has joined the growing number of homeowners who enjoy immediate savings with Grumman Sunstream™ solar domestic water heating systems.

Savings are considerable, because the hot water an average family of four uses for showers, washing clothes and dishes can be more than 27,000 gallons each year! The cost of heating this water can amount to 15% to 40% of your yearly heating bill.

The Grumman Sunstream system is an investment that will pay increasing dividends as conventional energy costs continue to rise.

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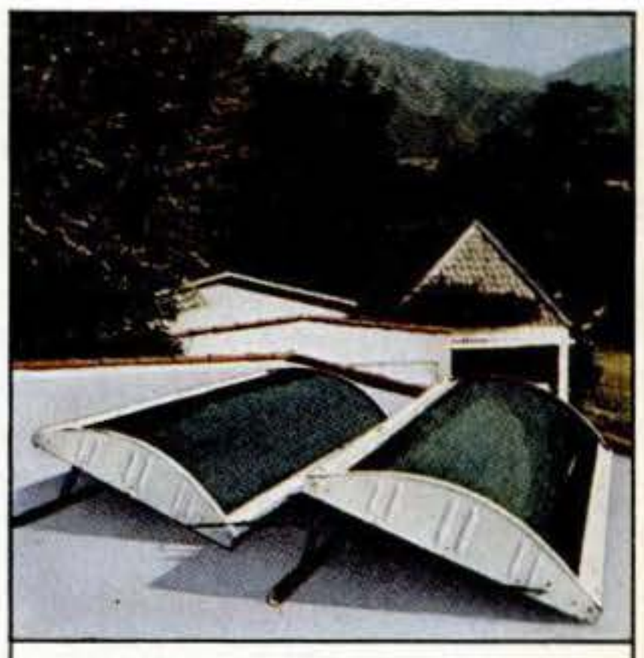
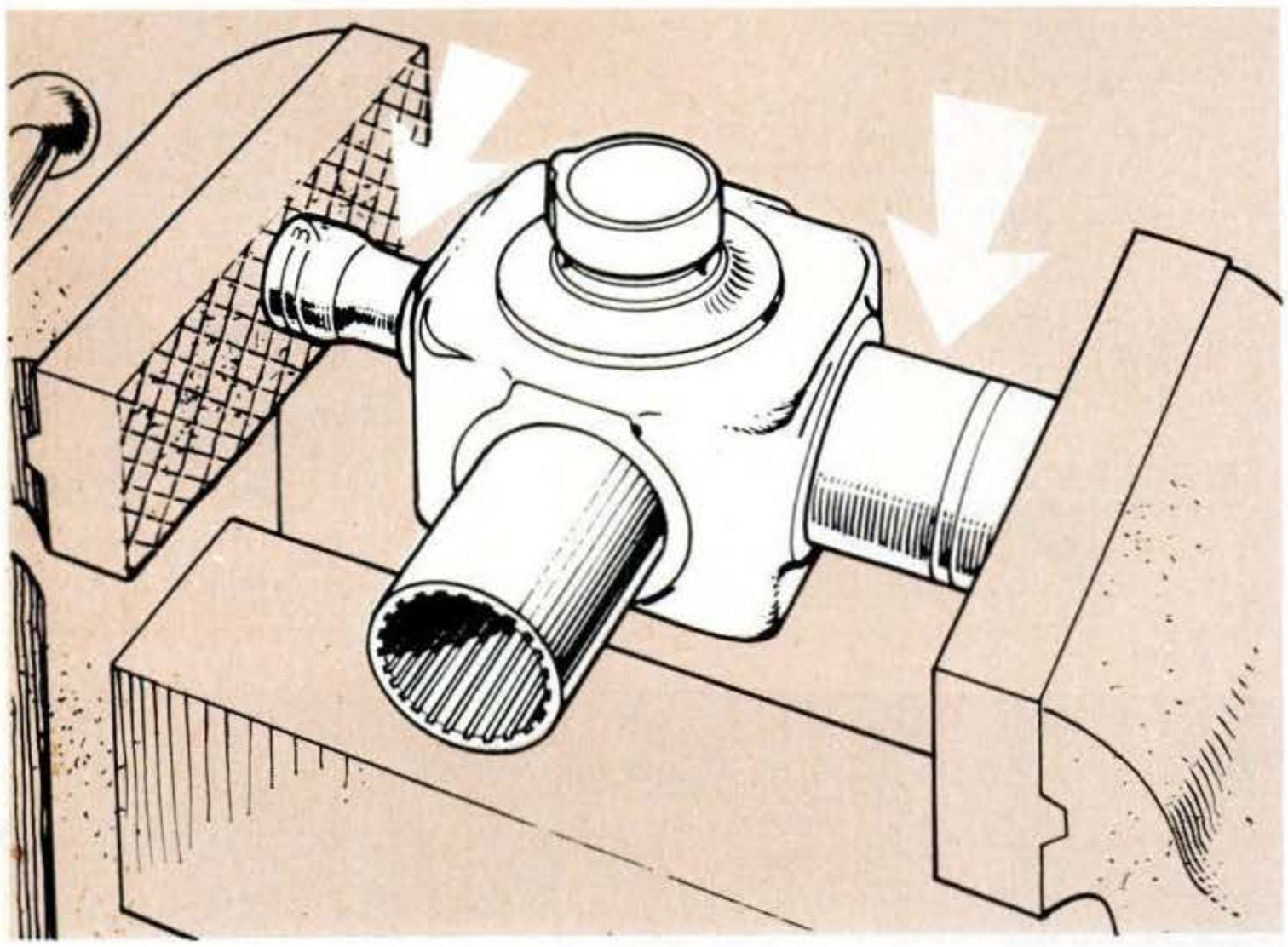


Sunstream collectors on the Crawford home in California.

TAKING CARE OF YOUR CAR

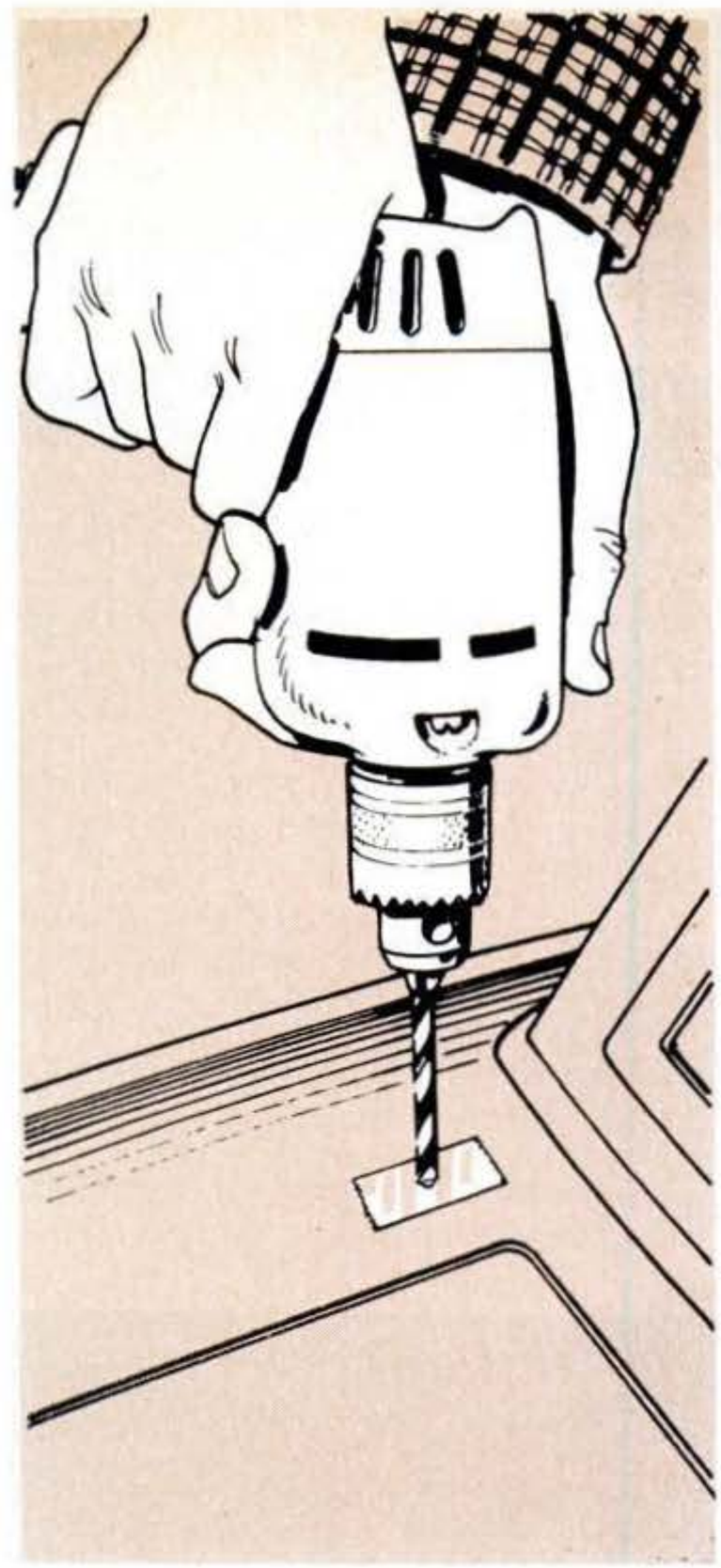
By RICH CEPPOS

Got a useful car tip? Send it (with Social Security No.) to Car Care, Popular Science, 380 Madison Ave., New York, N.Y. 10017. We'll pay you $25 if we use it. If two or more readers send in the same usable tip, the one with the earliest postmark will be chosen. Sorry, but tips can't be returned.



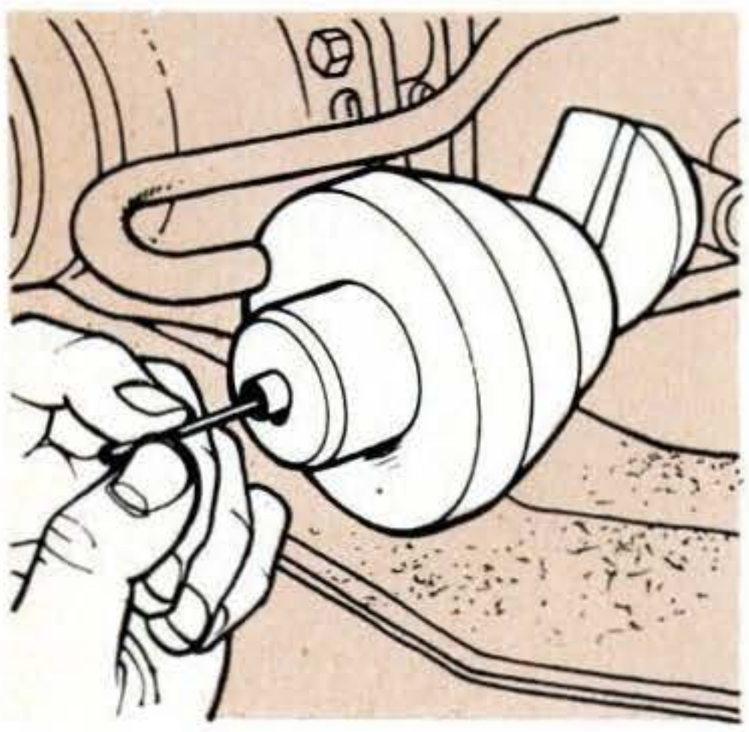
Installing bearings on drive-shaft U-joints

When repairing a drive-shaft universal, don't hammer in the bearing cups if you don't have use of a press. You run the risk of the bearings shaking loose from the cup even if they are well greased. Instead, create a makeshift press with a vise and two sockets. One socket should be small enough to pass through the yoke and the other large enough to support the yoke against the vise. Position the sockets and drive shaft as shown and gradually close the vise. This will force the cups in place on the crosspiece.



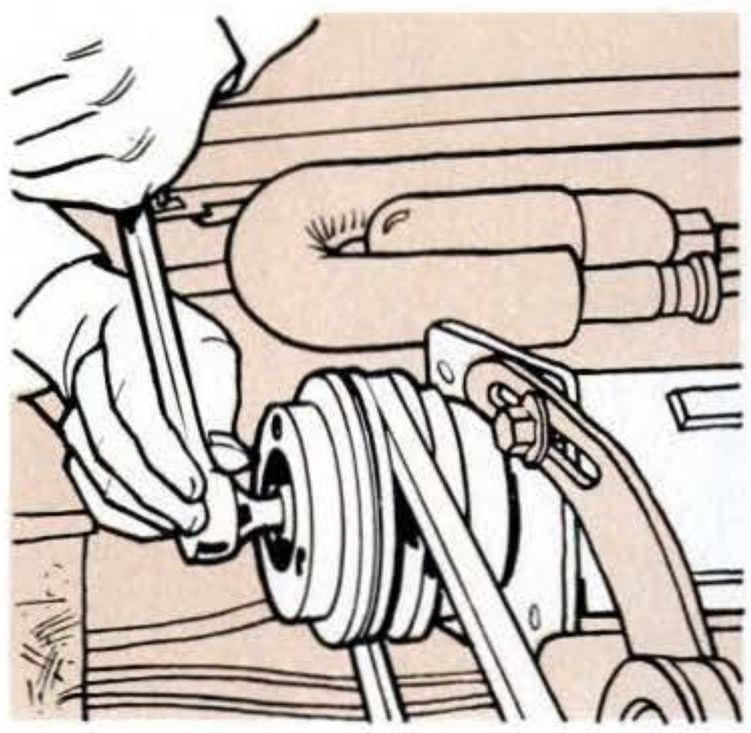
Drilling sheet metal

Protect the surrounding paint by covering your punch mark with a strip of masking tape. This keeps the bit from "skating." To keep the chuck from scratching the paint if you should break through suddenly, slip a rubber grommet or pad over the bit.



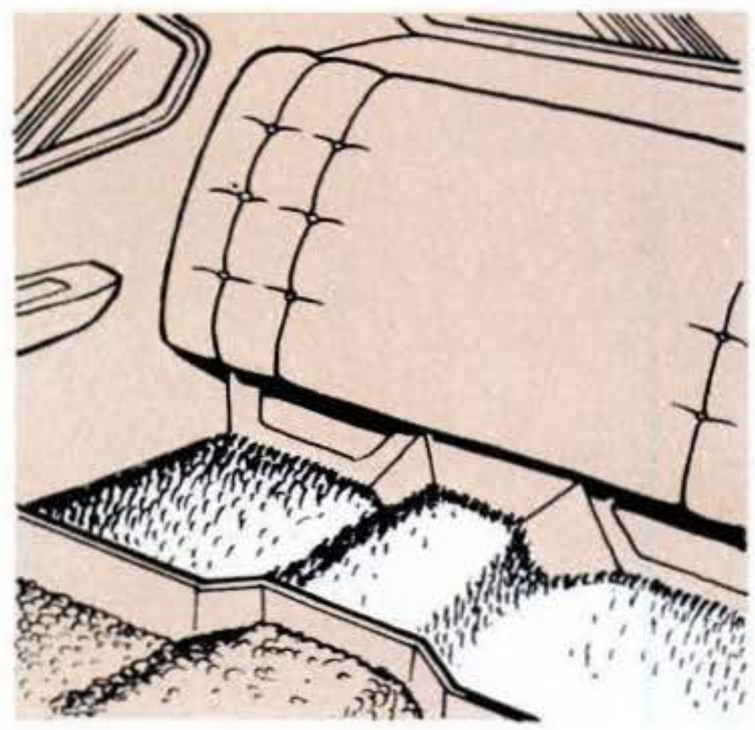
Finding a faulty modulator

Automatic transmission shifting harshly, late, or not at all? Don't rush off to your transmission repair shop, because the problem could be as simple as a faulty vacuum modulator or modulator hose. First, visually check the hose for leaks or restrictions. If there are none, disconnect the hose and insert a pipe cleaner into the modulator. If there is any transmission fluid in the modulator, replace it.



Seized A/C compressor

Air-conditioner compressor seizures don't necessarily mean the unit must be replaced. The lubricating oil sometimes drains from the bearing surfaces when the compressor is not in use, and can lock the unit solid. Break the compressor shaft free with a wrench and rotate it three full turns. This may get enough oil back to the bearings to allow the unit to turn freely again.



Quieting the interior

Don't throw that old carpet padding away—it makes an excellent low-cost sound deadener for your car or van. Cut pieces to fit below the rear-seat cushion, behind the rear-seat back, under the trunk mat or the interior carpeting. Other pieces glued to the trunk's interior sides will serve double duty as acoustic padding and will prevent sliding cargo from denting the trunk from the inside.

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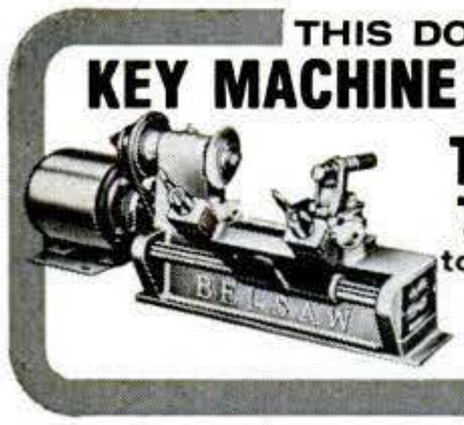

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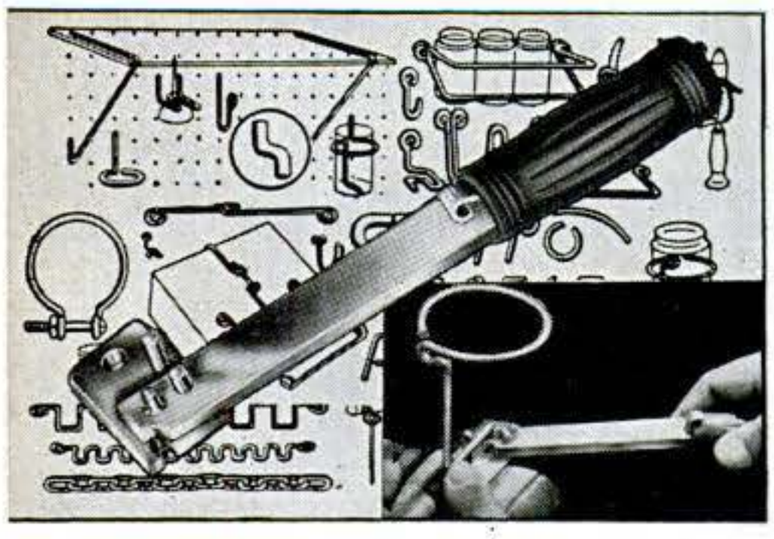

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Self-checking checks

What's the counterfeiter's latest trick? Stealing payroll checks and reproducing them on a color copier. But a new check developed by the Burroughs Corp., Rochester, N.Y., should foil this ploy. Put one of its Super Safety II checks into a color copier and what you'll get is the word "void" in big letters across the face of the copies.

Using various printing techniques, Burroughs, a major check printer, designed the Super Safety II with a decoy watermark printed on the check's back, and a colored background on its face that shields several safety elements.

"The word 'void,'" explained Burroughs' Bob Scott, "is spelled out by a series of fine colored dots and is then concealed under a field of coarse colored dots. When the checks are copied the coarse dots 'fall out,' leaving only the fine dots and a very disappointed crook."

I tried to duplicate several of the checks with a color copier. At normal setting, the word "void" stood out clearly. However, at lighter settings the "void" was difficult to see and the colored background either turned completely white or speckled shades of red and blue. In any case, you can't get the copies to resemble the original.

The artificial watermark printed on the reverse side of the check is done with a special, nonphotographic shadowed ink. To see the watermark, you must hold the check at an angle, which tellers are instructed to do. I could not successfully duplicate it on any copier.

And the check has a final trap for forgers. When I tried to alter the amount and the signature on the check with ink eradicator, I discovered that hundreds of small "voids" in three languages are printed underneath the surface tint.—*David Hoover*

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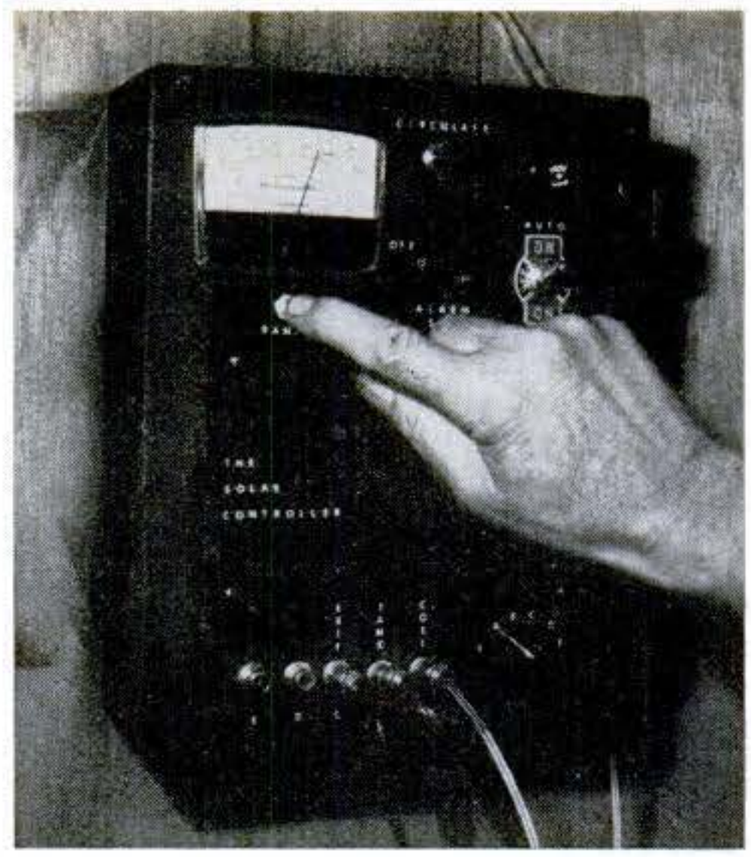
For your solar water heater, build a temperature control



Sensors A and B are monitored for a difference in temperature; other three report temperature or actuate alarm only.

Two IC chips display and maintain efficient control

By THOMAS RUSSELL

If you've been following past issues of PS, you may have already built a flat-plate solar collector to heat the hot water in your home. If so, or if you're planning to install a system, you also need a way to control it efficiently—you need this solar controller.

The solar controller is basically an electronic thermostat with a few additional features:

- It monitors collector and tank temperatures and acts as a differential controller. The pump is actuated when the collector temperature exceeds the tank temperature by a preset amount.
- It's an electronic thermometer, displaying the temperatures of up to five separate points in the system. The accuracy of the meter readout is one degree over 0-100 degrees C.
- And it has an automatic alarm circuit that is triggered by excessive temperature at a selected point in the system. This, of course, can be used to check the collectors for overheating.

The system is designed around two inexpensive operational amplifier IC chips. They are used to measure a small voltage across the two diodes used as temperature sensors at each point. This voltage changes in a linear proportion to the temperature "felt" by each sensor. The IC's use the voltage to determine the difference in temperature between two sensors for

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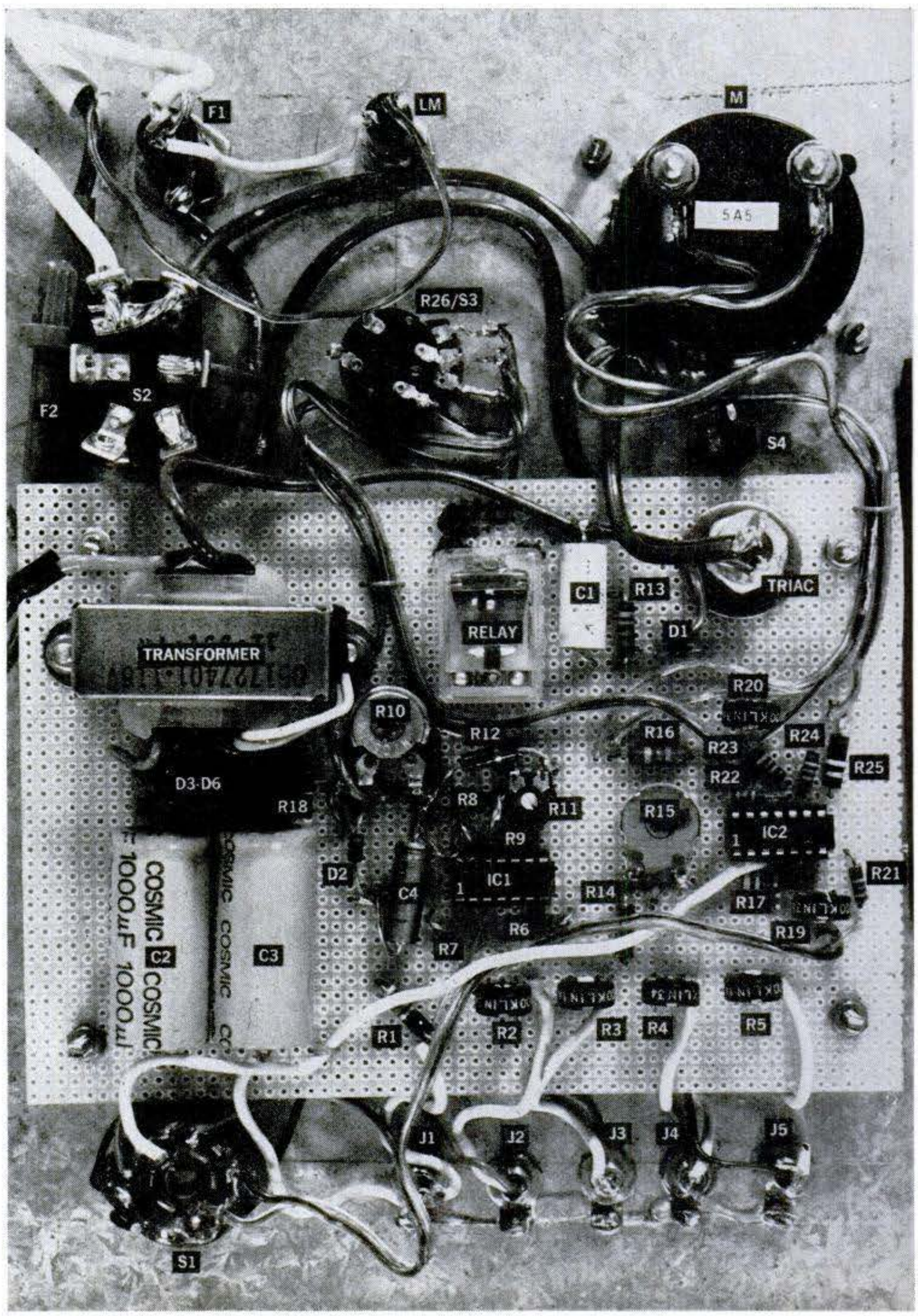

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You're getting very close.

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Walk two blocks toward the setting sun and half that distance toward the nearest city reservoir. There, at a very prominent address, higher up than the eye can see, someone is ready to hand you the case of Canadian Club when you say, "C.C., please."

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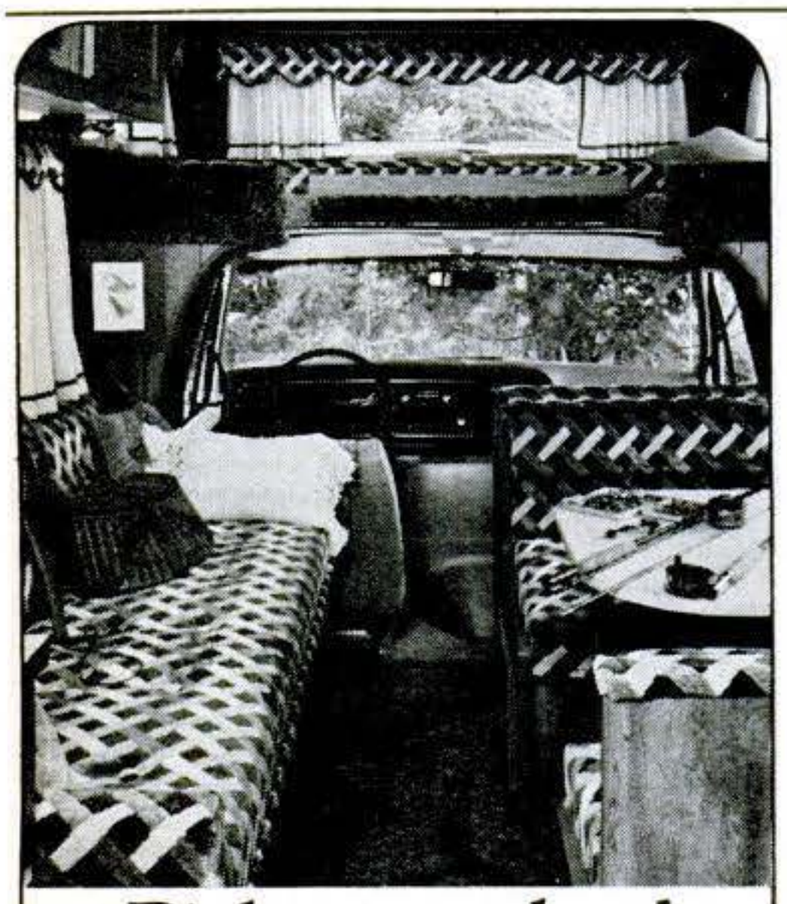

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Parts list

R1—47,000-ohm, 1/4-W resistor
R6, 7—1500-ohm, 1/4-W resistor
R8, 9—240,000-ohm, 1/4-W resistor
R12—1200-ohm, 1/4-W resistor
R13—22,000-ohm, 1/2-W resistor
R14—15,000-ohm, 1/4-W resistor
R16—1500-ohm, 1/4-W resistor
R17—3300-ohm, 1/4-W resistor
R18—100-ohm, 1/2-W resistor
R21, 22, 23, 24—470,000-ohm, 1/4-W resistor
R25—100,000-ohm, 1/4-W resistor
R2, 3, 4, 5, 11, 19, 20—100,000-ohm, 1/4-W potentiometer
R10—5000-ohm, 1/4-W potentiometer
R15—500-ohm, 1/4-W potentiometer
R26/S3—10,000-ohm linear taper potentiometer w/SPST switch
C1—0.1-mfd capacitor
C2, 3—1000-mfd @ 25-V electrolytic capacitor
C4—10-mfd @ 15-V electrolytic capacitor
D1—ECG 6406 trigger diode
D2—1N4742 12-volt, 1-watt zener diode
D3, 4, 5, 6—1N4001 diode
Sensors—1N4148 diodes (get 15-20)
Triac—ECG 5665 10-A @ 200-VAC stud-mount triac
IC12—LM324N Op Amp
LM—Neon panel lamp 120 VAC
T1—12 VAC secondary @ 300 mA
Relay—12-VDC 1200-ohm coil, SPST
Meter—50 microamps, 1000 ohms
Alarm—Mallory Sonalert (DO NOT SUBSTITUTE)
S1—2-pole, 6-position rotary switch
S2—SPDT center-off toggle switch 10 A @ 120 VAC
S4—SPST normally open momentary push-button
F1—5A 3AG fuse and panel-mount fuse holder
F2—0.25A 3AG fuse and in-line fuse holder
J1-J5—Panel-mount phone jacks or equivalent
P1-P5—Phone plugs
Misc.—4.5" x 6" epoxy vectorboard, 8" x 10" metal plate, 2 14-pin IC sockets, No. 22 solid wire.
Note: All components are available from Williams Electronic Supply, 1863 Woodbridge Ave., Edison NJ 08817.

pump control, provide a corresponding drive voltage for the temperature meter readout, and determine when the alarm limit is reached.

The perforated board is mounted on the front panel plate, which also holds the remaining components. Use 14-gauge wire for the pump-control wiring.

The temperature sensors are two diodes wired in series. As shown, solder the two ends of each diode together and connect the free ends

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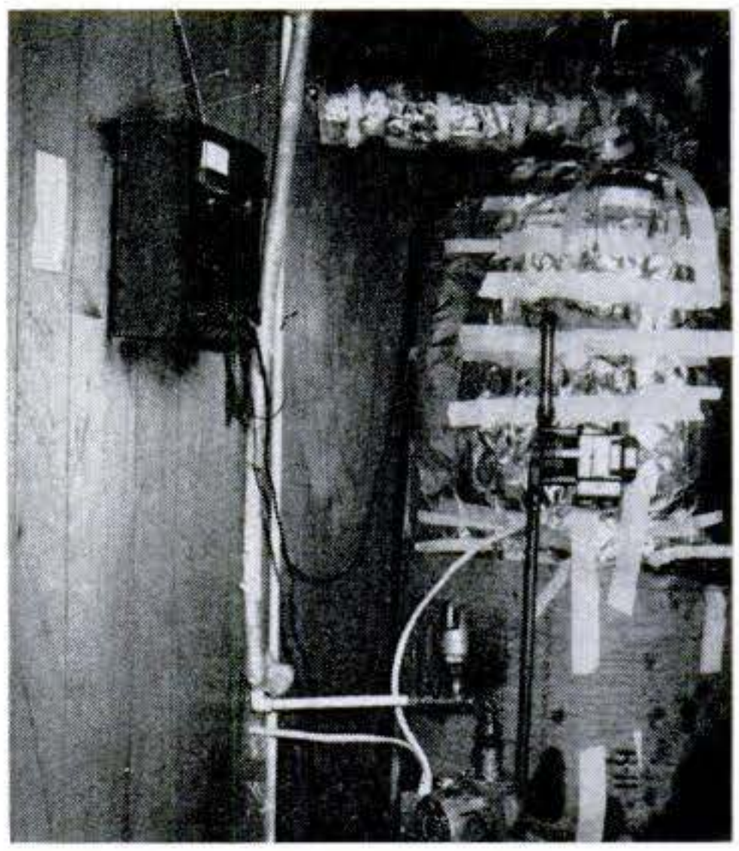

Use a grounded AC line to bring in power and chassis ground to the controller box. Keep sensor wires orderly.

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Showing off your new diesel pickup.

Ol' Gib who runs the filling station doesn't impress easy. But the sight of your new GMC sure did bring him out of his chair. After all, it was his first chance to get a look at one of this country's first diesel-powered pickups—and a *V-8* diesel at that.

Of course, you don't have to tell Gib a thing about diesels. He knows all about 'em from the 18-wheelers. Like how simple they are: no spark plugs, points, condenser, rotor, distributor, carburetor or catalytic converter to fuss with.

And talk about engine maintenance. Why, according to the owner's manual, all you have to do is change the oil and filter every 3,000 miles in normal operation, and give the crankcase ventilation a check every 6,000. Now that's easy to live with.

And the benefits don't stop there. EPA mileage estimates are impressive. 20 mpg city. 27 mpg highway. These ratings were achieved with the new 5.7 litre diesel engine and standard automatic transmission. Your mileage depends on how you drive, where you drive, your truck's condition, and its available equipment. Note: GMC pickups are equipped with GM-built engines produced by various divisions. See your dealer for details.

One more thing. As old Gib knows, diesel fuel traditionally costs less. In July, 1977, diesel fuel was 10¢ per gallon less than unleaded regular gasoline, according to the Office of Energy Information and Analysis Report dated 9/77.

So be one of the first. See your GMC dealer and ask him about the new GMC diesel pickup.

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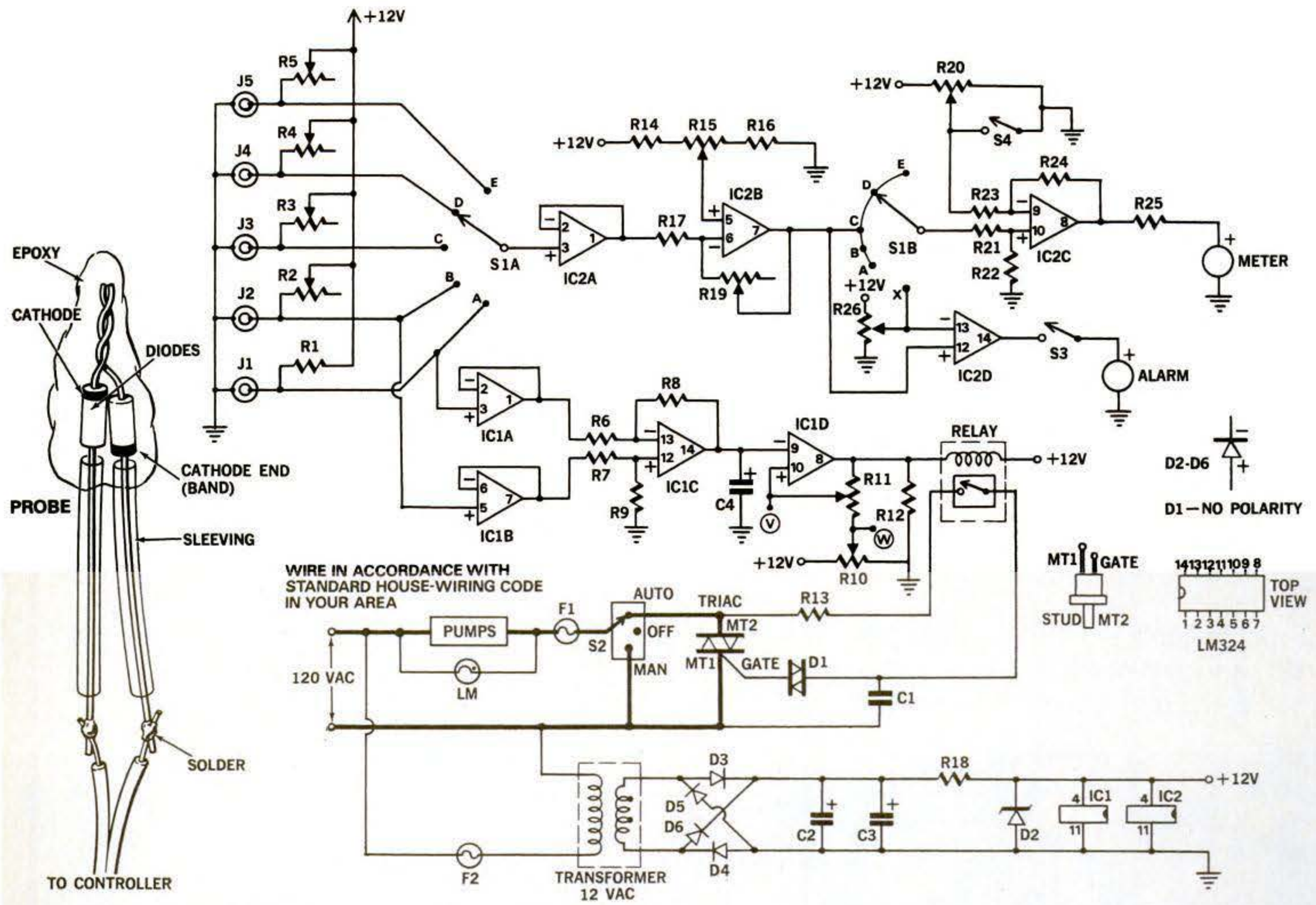

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to a two-conductor cable. Use spaghetti tubing to insulate the leads and encapsulate the whole thing in epoxy for protection. Make up a few extra probes for the final tests.

Select one probe and connect a length of wire sufficient to reach the collectors from the permanent location of the solar controller. Connect the probe with wire to a plug and insert in socket A.

Prepare a bath of ice water (0°-5° C) and a bath of hot water (40°-50° C). Monitor the bath temperature with a good thermometer throughout the calibration procedure. Immerse the sensors in the hot bath and depress and hold range switch S4. Adjust gain control R19 for correct reading on the meter. Move the probe to the ice bath and adjust control R15 for proper reading. (Make sure S4 is still depressed.) Repeat this procedure with hot and cold baths until the meter reads correctly over the range of 0°-50° C. Prepare a new bath about 80° C. Immerse the sensor, and with S4 released, adjust range control R20.

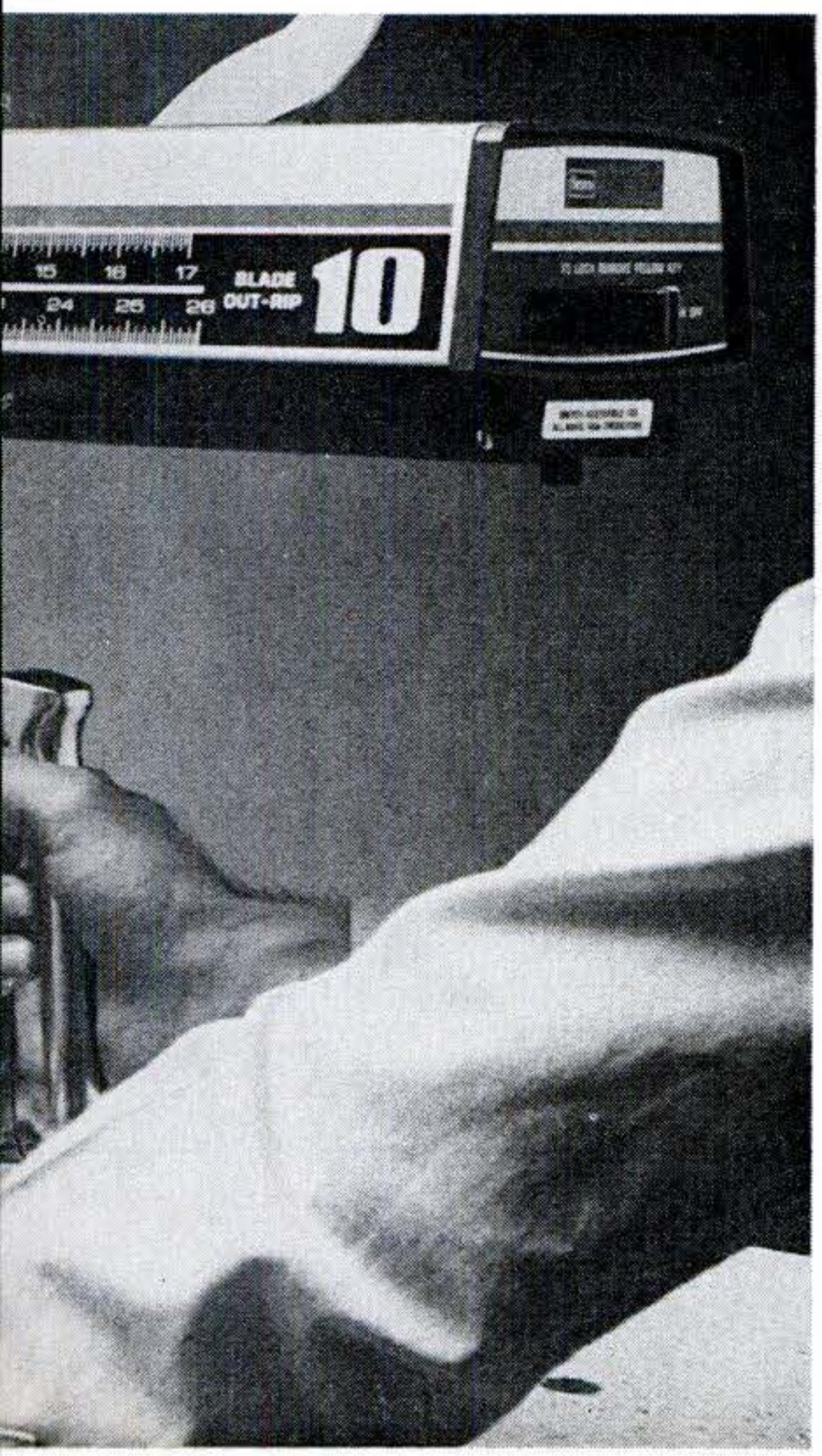
Additional probes may be connected to the sockets B through E and calibrated in a water bath of about 40° using their corresponding adjustment potentiometers, R2 through R5. After calibration, check the sensor over the full temperature range.

To calibrate the pump controller, connect and calibrate a sensor at B. Prepare two baths, one about 30° C and the other 8° warmer. Set the mode switch to AUTO and preset R10 for 3.0 VDC at "W" (see schematic). Place sensors A and B in the cooler bath and wait a minute. Set R11 for 12 VDC at "V". (If you cannot achieve this, reset the trigger circuit by briefly connecting point "V" to 12 VDC.) Move sensor A to the warmer bath and wait for the meter reading to stabilize. Turn R11 until the indicator light just comes on. Place sensor A back in the 30° bath: When the meter reads about 32° C, the lamp should go off. If the lamp goes out too soon, decrease the voltage at point "W" by adjusting R10. If the lamp goes out too late, increase the voltage. Reset R11 to 12 VDC and repeat this procedure until operation is satisfactory.

The solar controller is now ready for use. Install sensor A at the hottest point in your collector array. The outlet pipe from the last collector is a good choice. Sensor B mounts at the coldest point of the storage tank. Sensors C through E can be placed anywhere you wish for monitoring separate temperature points. The alarm device you use can be placed anywhere in audible range.

Setting the mode switch S2 to the AUTO position allows the solar controller to operate the pumps. The MANUAL and OFF positions let you control the pump manually. The selector switch S1 determines which sensor is being monitored by the meter (it reads directly in degrees C). Depressing the range switch S4 gives a 0-to-50-degree readout; release and it reads from 50°-100° full scale.

To set the alarm, switch the selector to the x position and adjust the alarm-set control to the desired temperature as indicated on the meter. Now switch the selector to the sensor you wish to monitor. PS



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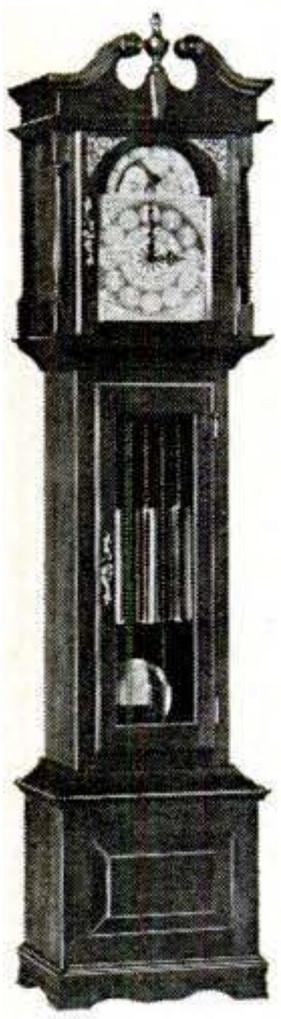

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Six-function auto computer gives instant mpg reading

As I was driving along I-75 in my Southwind motor home recently, I wondered what my mileage for the day was. So I pushed a button on my Autocomp—an mpg counter that gave me an instant display of total fuel used, distance traveled that day, average mpg since the last readout, elapsed time, and time of day.

The Autocomp's microprocessor circuitry does the calculations and then flashes the information on a bright LED display panel. And Autocomp never forgets. When you turn off the ignition, the display goes out, but the memory stores information about fuel consumption and continues to plot time.

The Autocomp is easy to install. First, I inserted a flow sensor in the gas line on a horizontal run between the fuel pump and carburetor. A speed transducer connects to the speedometer cable, automatic transmission, or cruise control. Wires from each of these sending units carry the input to the readout module.

The Autocomp will mount easily on, under, or in the instrument panel of your car. You can even custom-mount it, as I had to. My motor home had no mounting space on the instrument panel. But it did have a table support next to the driver's seat. I fitted a plastic pail around this, cut a hole for the readout module, mounted it, and carpeted the pail.

On road tests, the Autocomp performed without flaw, except that my prototype unit tended to "lock out," or stop reading, when a voltage surge occurred. I remedied the problem by installing a diode in the grounding lead to the display panel. Production units now come with this diode.

The Autocomp is made by SpaceKom. It's listed in the Sears automotive catalog and sells for about $130.—*Evan Powell*

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The Ultimate Lockback

The Uncle Henry® Bear Paw® by Schrade

Pivot Post/Lock Bar of Schrade + Steel® makes the Bear Paw completely rust resistant; insures the most rigid, durable construction ever offered in a lockback knife.

The 3½" blade of rust resistant Schrade + Steel opens and closes easier than any other lockback.

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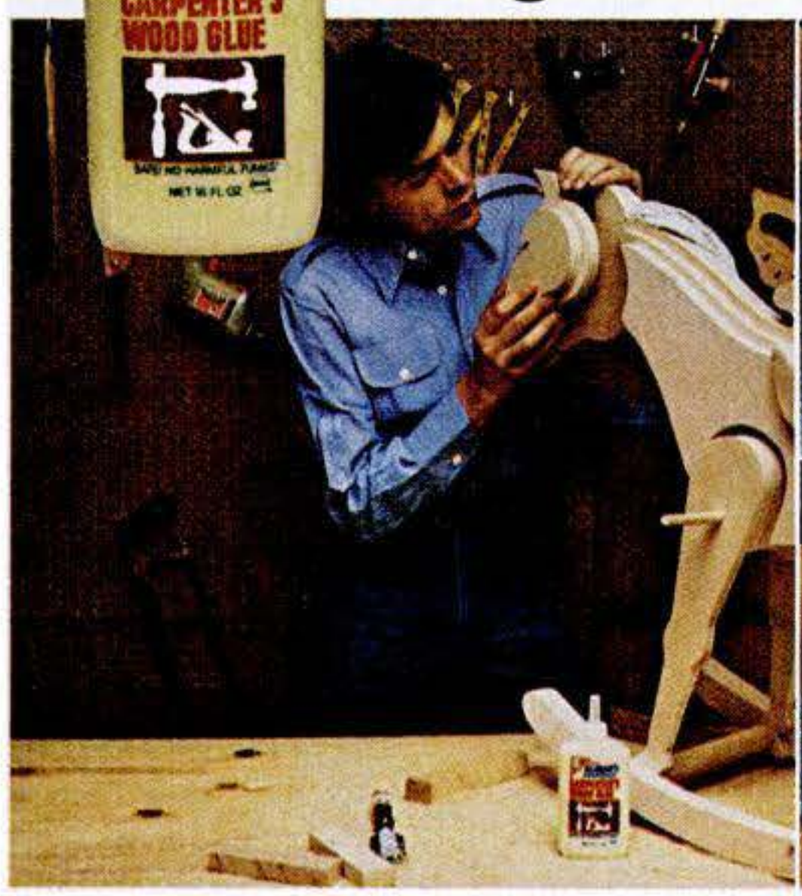
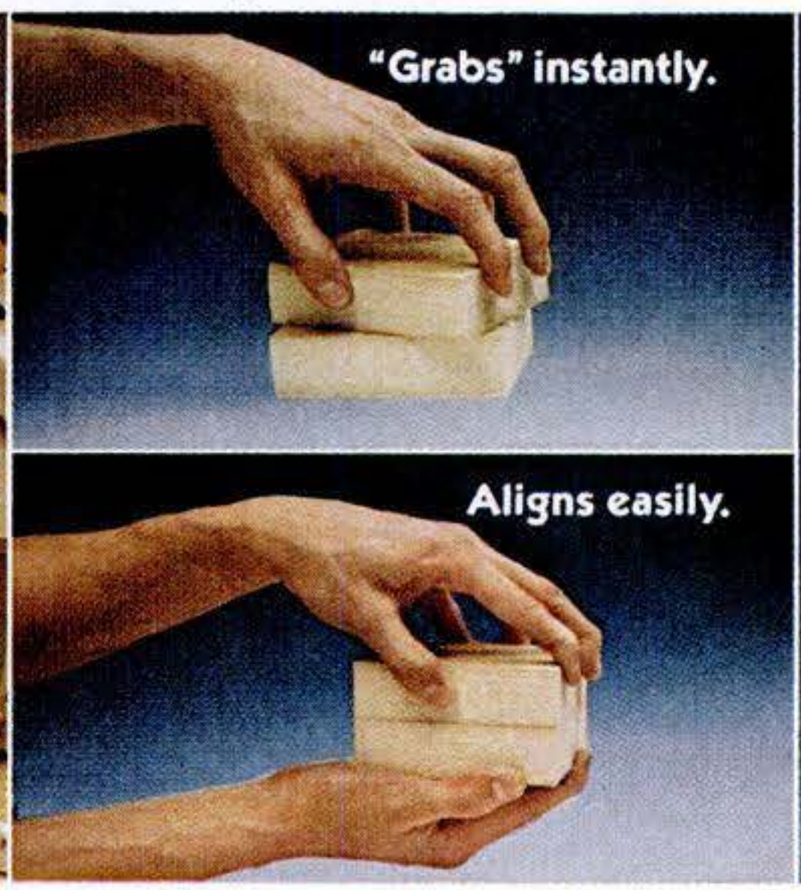
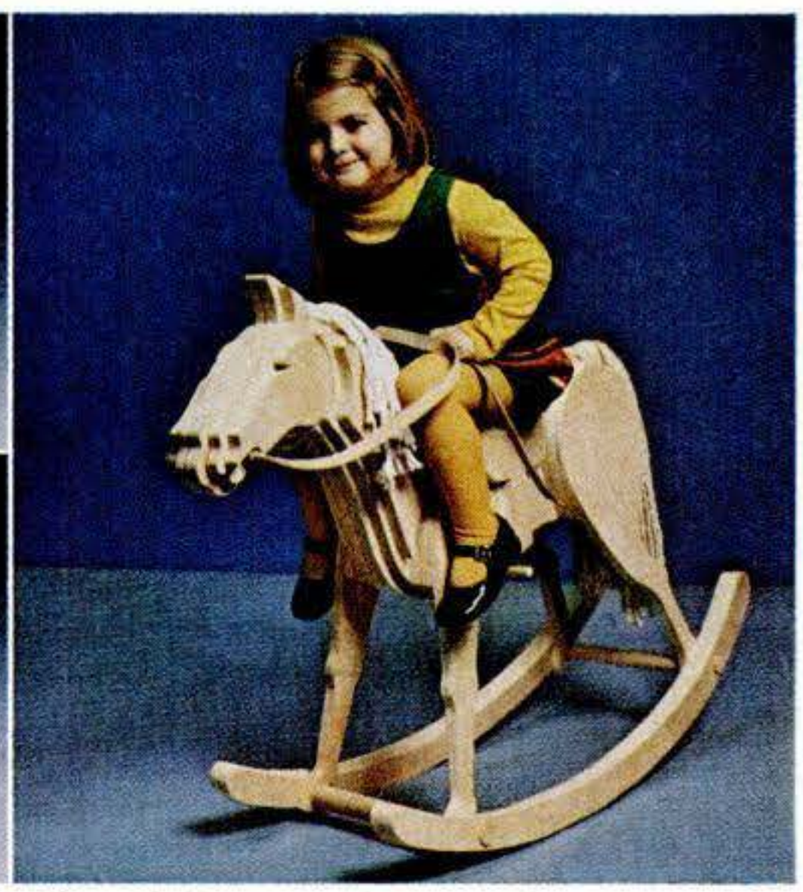
With Elmer's Carpenter's Wood Glue you don't need a pro's hands to give it the pro's touch.







Elmer's® Carpenter's Wood Glue is a special wood glue for all your woodworking projects. It penetrates well in hard and soft woods and forms a heat and water resistant bond that's stronger than the wood itself.

It's also better because it "grabs" immediately and dries fast. Yet it allows realignment before it sets. So you can join surfaces as soon as it's applied.

Elmer's Carpenter's Wood Glue is also sandable, paintable and gumming resistant. Its non-toxic*, solvent-free formula also washes off your hands and project with water. So you won't get light spots when you stain near glue joints.

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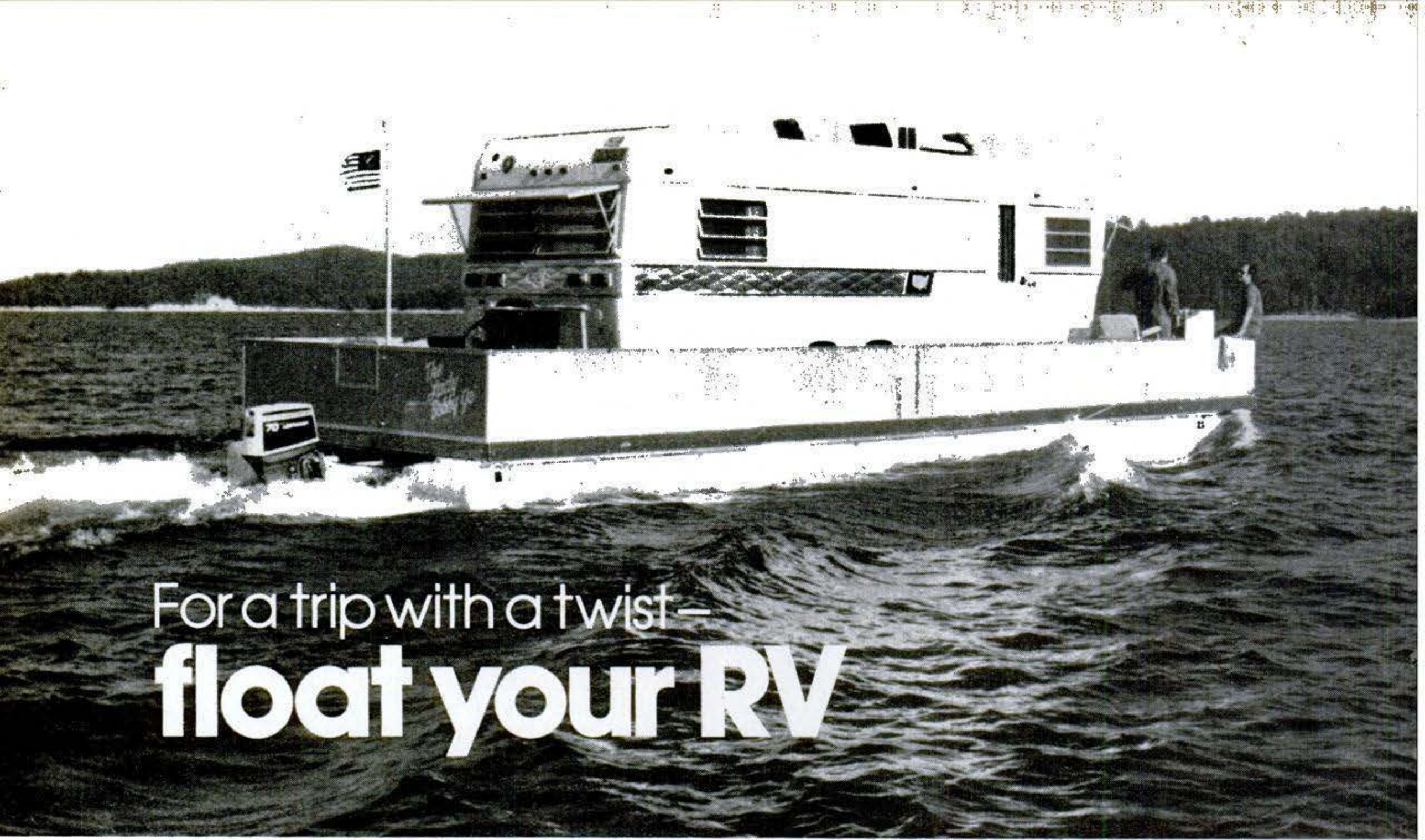

For a trip with a twist— float your RV

You can rent a pontoon rig that converts almost any RV into a houseboat

By BILL THOMAS

Houseboating's great fun—but it's usually costly and can be confining. Now, however, you can mate your recreational vehicle with a pontoon craft for a relaxed, inexpensive boating vacation.

The pontoon, made by a new company called Camp-A-Float, offers comforts, ease of handling, and a get-away-from-it-all experience that can win over the most skeptical critic. It was the most versatile houseboat we'd ever been aboard.

It was late summer and the camping season was over. But the enticements of Arizona's Lake Havasu were enough to create in us the urge to escape to some little-known place where solitude and seclusion lingered. As we drove into the marina parking lot at Havasu Springs, we felt anxious to get to some of the many coves we'd been told were part of this man-made lake on the lower Colorado.

The crew at Camp-A-Float backed our El Dorado mini-motor home onto an elevated pontoon boat, positioned it dead center, tied it down securely, and lowered the rig into the water. It takes just 15 minutes to secure most RV's to the pontoon craft.

Craft is powered by outboard motor that's controlled from a helm stand in forward corner. You get a complete checkout cruise before you take off.

The pontoon is powered by an Evinrude 65-hp outboard that's easy on gas, yet provides plenty of power to push the craft along at 12 to 15 knots. The outboard is controlled from a helm stand up front that gives you full view of the water ahead and to the sides.

11,000-pound limit

The El Dorado mini-wagon fit comfortably aboard the 40-foot pontoon. Its 9000-pound weight (with groceries, water, gas, etc., aboard) was just about the limit recommended for the pontoon. But larger pontoons are now available that will carry RV's weighing up to 11,000 pounds. The Camp-A-Float pontoon will accommodate any RV up to 31 feet in length. It's equipped with 40 gallons of on-board gasoline, enough to cruise for 20 hours without refueling. It also comes equipped with 100-gallon holding and 100-gallon fresh-water tanks. Both connect to the RV.

The vehicle is secured to the pontoon by stabilizer jacks to prevent bouncing and tie-down binders

Continued

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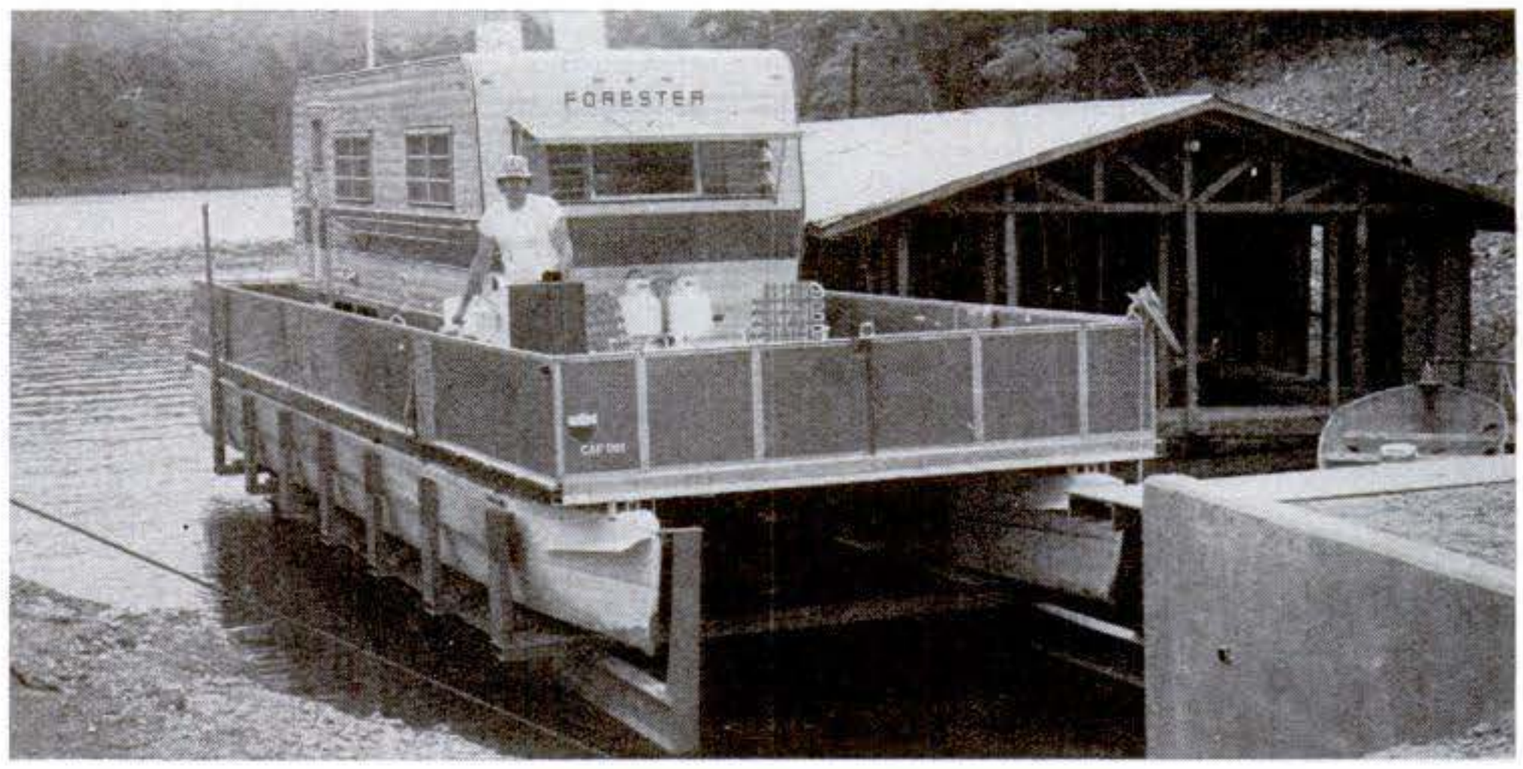
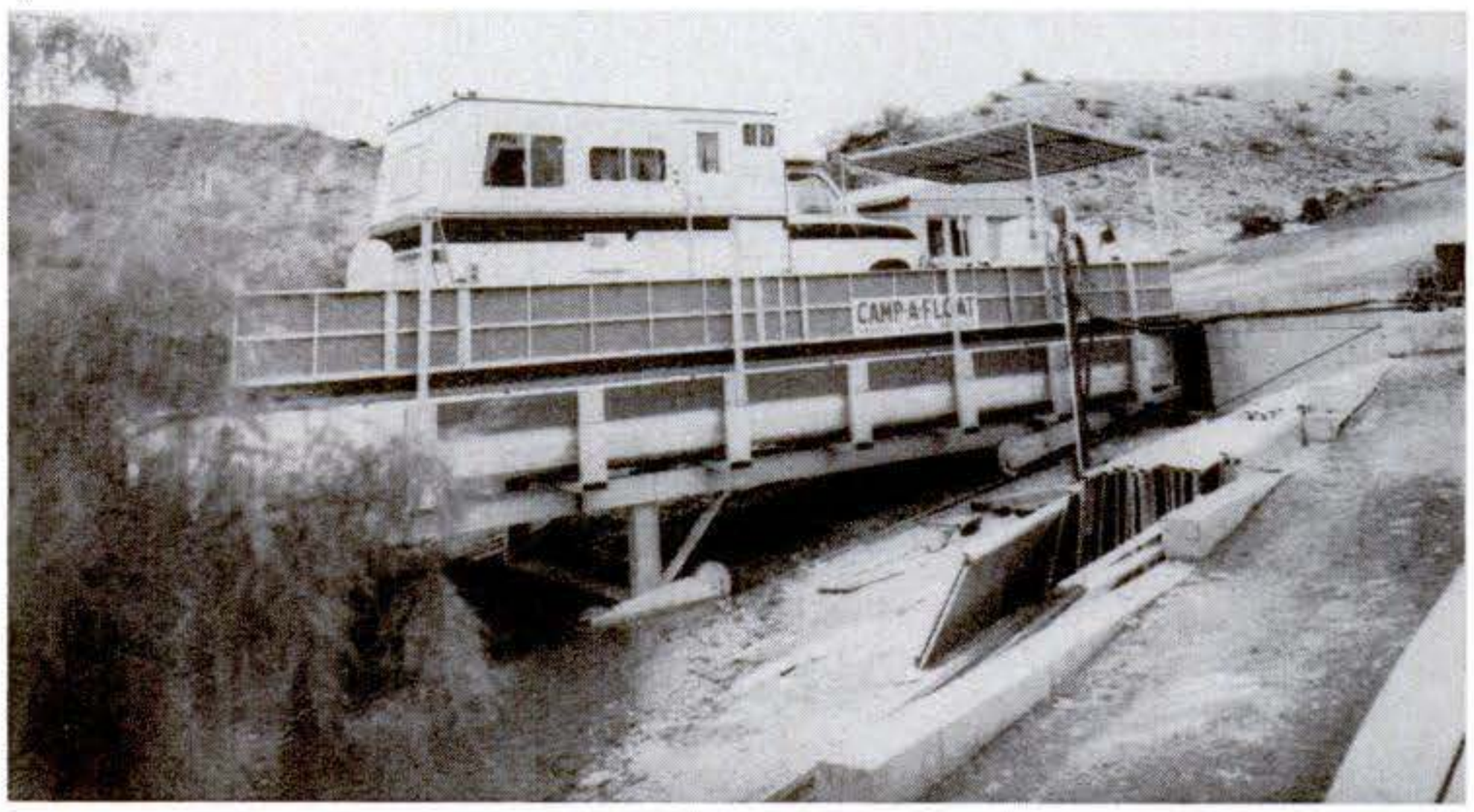
Float your RV

[*Continued*]

(similar to those used on logging trucks). The camper must be positioned dead-center on the craft for best performance of the boat.

Richard Reed, president of CAF Industries and designer of Camp-A-Float, says the conversion concept intrigued him for years. "The more recreational vehicles I saw on the road, the more I felt there should be alternate ways to use them. Statistics show most RV owners head for a water-oriented spot during their vacation—so why not camp *on* the water instead of *near* it?" PS





When you're ready to return the rig, Camp-A-Float operator maneuvers craft over submerged carriage—actually a short section of marine railroad. It's shown in partially raised position in the top photo. Once the pontoon deck has been raised to road level, you're ready to drive—or tow—your RV away (bottom).

How to rent (or buy) your pontoon

Camp-A-Float rental pontoons are available at Lake Hartwell, covering 56,000 acres on the Georgia-South Carolina border; Lake Ouachita, a 40,100-acre lake near Hot Springs, Ark.; and at Lake Havasu in Arizona. The company says facilities are expected to be ready for the 1978-79 season at Lake Powell on the Arizona-Utah border; Lake Texoma on the Texas-Oklahoma border; Lake Amistad, an impoundment on the Rio Grande River between Texas and Mexico; the Sacramento River delta in California; the Kentucky-Barkley lakes complex in Kentucky (the two are connected by a canal); and the inland waterways of Florida. Rental rates range from $220 per week during the winter season to $280 weekly during the summer. If you don't have an RV, fully equipped units may be rented for an extra $100 to $150 per week. You can even buy your own pontoon from Camp-A-Float. Base price is about $7000. Under a lease-back purchase plan, an owner offers his boat for rental, thus realizing a return on his investment. To make reservations for a Camp-A-Float pontoon, call toll-free 800-528-8114 or write CAF at 101 So. 30th St., Phoenix, Ariz. 85034.

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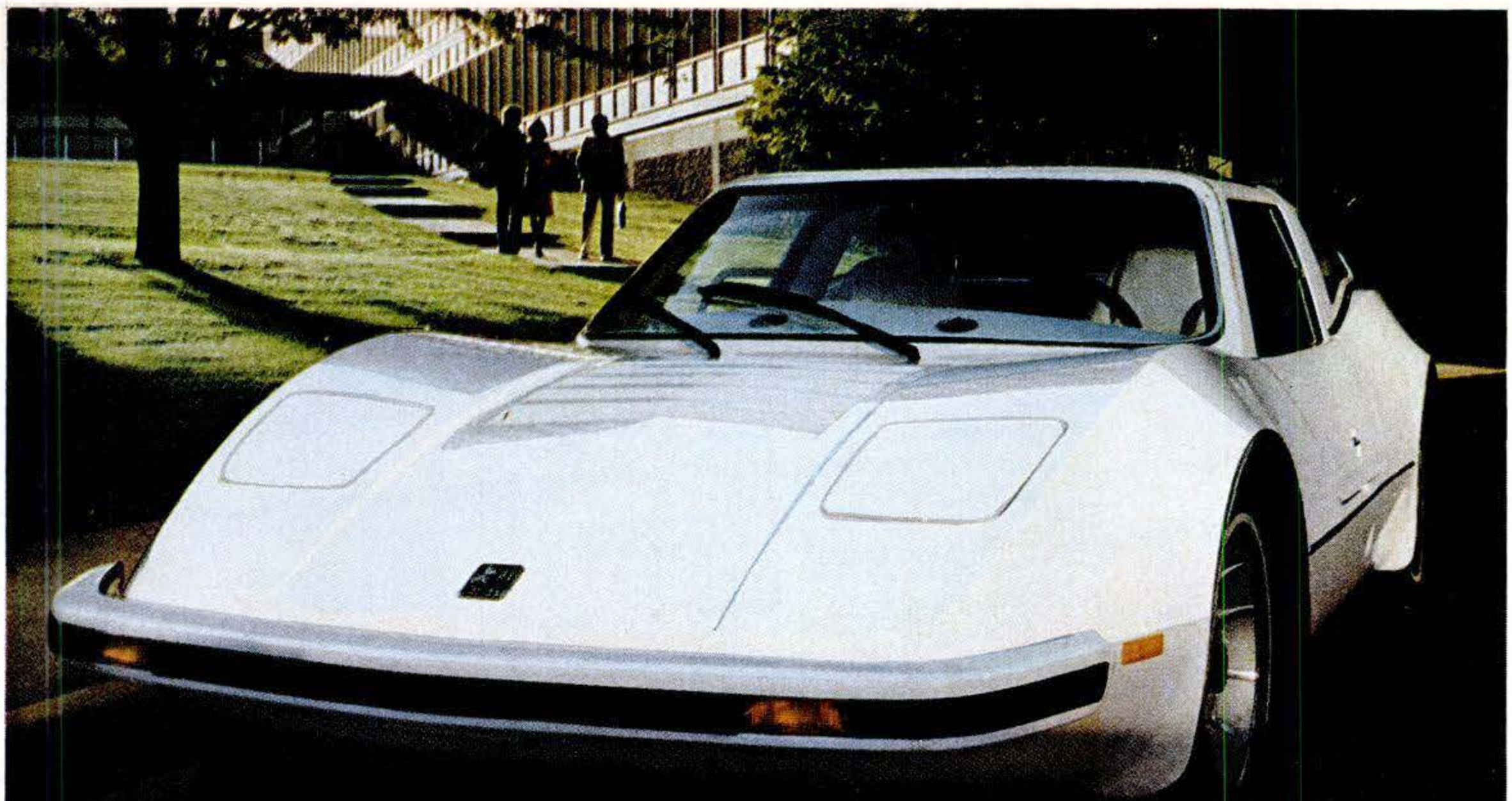

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Its many amenities include fiberglass gull-wing doors and hatchback rear door. A steel reinforced roof and fiberglass body. Tinted safety glass windows. European-styled instrument cluster. Electrically-powered pop-up headlamps. And so much more.

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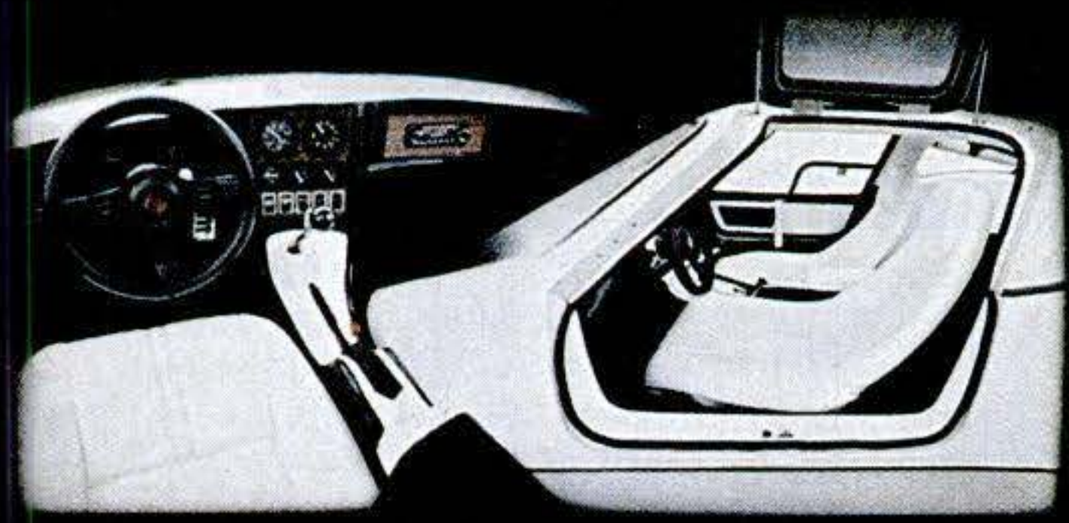

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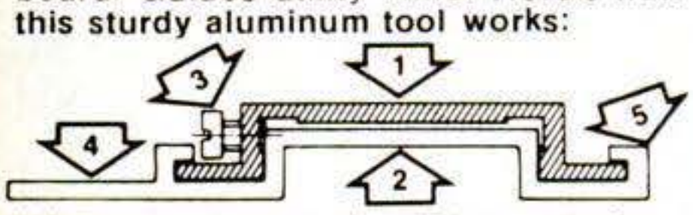

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Cable-drive log splitter

Until just a few years ago, power log splitters were available primarily to professional wood cutters and rental equipment shops. Then along came the big boom in wood heat, and the demand for cheap, effective "homeowner" splitters shot up sharply. First came the screw-type splitters such as the Stickler and the Unicorn [PS, March and Oct. '77].

Now there's a new type called the Woodsman. It operates like the big hydraulic units the pros use, but works on a different principle. Instead of hydraulics, the Woodsman uses a simple V-belt clutch system that winches aircraft cable over a series of eight sheaves. The cable pulls a pusher plate that drives the log against a steel wedge.

This system is so efficient that the Woodsman needs only a four-hp engine to do the job. I fed it 16-by-16-inch oak logs, complete with big knots and crotches. The engine didn't even slow down.

The Woodsman will handle logs up to 23 inches long. Price is $595—about what you'd pay for the cheapest hydraulic units for home use.

Three minor beefs: the ingeniously simple clutch system will burn V-belts if allowed to idle more than 30 seconds. Undersize wheels dig into soft ground and hang up on the smallest obstruction. (Bigger tires, like the pneumatics found on good wheelbarrows, would be an improvement here.) And a narrow stance makes the machine tippy when rolling over uneven ground.

Beyond that, it's hard to fault this machine. It's made by Thrust Mfg. Co., 6901 S. Yosemite St., Englewood CO 80110.—*A. J. Hand*

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These two McCulloch chain saws are loaded with the kind of features that make backyard projects a whole lot easier.

Take the Mac 140, for instance. It's got Chain Brake/Hand Guard to reduce the hazard of kick-back. Big 14" sprocket tip bar. Auto-Sharp to sharpen the chain with a press of a button. Both automatic and manual bar and chain oiling. Plus a handy carrying case. You can't buy another chain saw with all these features at any price.

Or the Pro Mac 10-10, built for heavy-duty cutting. Its powerful 3.3 cu. in. engine and 16" sprocket tip bar will make short work of just about any job. Plus Chain Brake/Hand Guard and automatic and manual oiling. It's McCulloch's best selling saw.

Put one of these McCulloch chain saws to work. Whether you're cutting firewood or fenceposts, McCulloch will sink its teeth into your home cutting jobs.

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Expanded-range **arc welder**

Some arc welders are just plain hot. This new Sears 30-295-amp outfit is one of them. You sense it as soon as you strike an arc. One touch and you're welding. It doesn't seem to matter much just how you drag or tap the rod. The arc is instant and stable, and you don't get a lot of popouts, sputters, and erratic bead deposits. Moreover, you find yourself cutting back on amps because there's more performance than your experience tells you to expect from a given setting.

If you've ever tried welding down in the 30-50-amp range you've likely been frustrated by endless strikes trying to establish an arc and hold it on light metal. I started out with this unit at 50 amps and got a stable arc on the first strike. I dropped back to 40 amps and did the same. Finally, I tried 30 amps, fully expecting trouble. I still got a stable arc on the first strike. This was with 1/16″ 6013 rod on some rusty 1/16″ steel I hadn't bothered to clean. Clearly, Sears' 20139N welder can do the job at the low end, and this is an ability that isn't often duplicated by small sputter-boxes even though they have the same amp rating.

From there I worked up through the dual range using 3/32″, 1/8″, 5/32″, and 3/16″ rod.

That's the beauty of this expanded-range $199 welder: You can weld anything from very light materials to structural steel just by swinging the range-control handle.—*E.F. Lindsley*

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NOW THERE'S MORE TO LUV THAN EVER.

The available 7½-ft. pickup box —longest of any economy-size pickup in the industry—heads the list of improvements.

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With a GVW rating of 4,150 lbs., the long box model can carry payloads of up to 1,635 lbs. including driver, passenger, equipment and cargo. Regular-size LUV with a 6-ft. box is a bona fide half tonner, too. With a GVW rating of 3,550 lbs., it carries payloads of up to 1,125 lbs.

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Those impressive figures are EPA estimates with standard 110.8 CID engine and manual transmission. Your mileage will vary depending on how you drive, your truck's condition, where you drive, and your truck's available equipment. California EPA estimates are 30 miles per gallon highway and 22 miles per gallon city.

Regular-size LUV with 6-ft. box and available "Mighty Mike" striping.

NEW SOFT-RIDE SUSPENSION.
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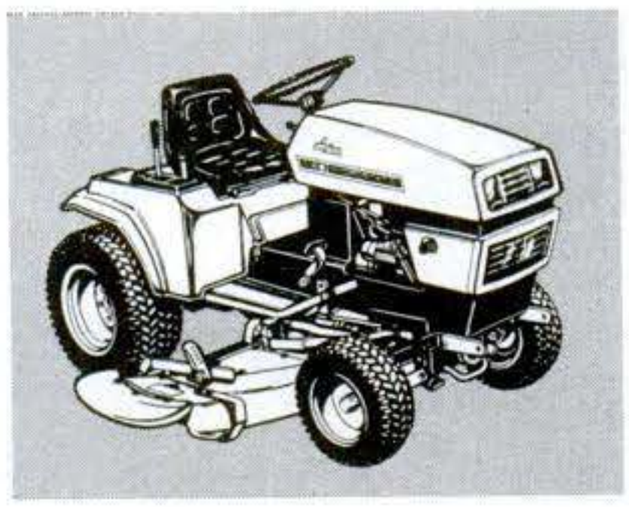

When you're shopping for a garden tractor, Ariens feels that taking the time to compare various tractor makes will be a rewarding experience and time well spent. Ask questions about each like:

1. **How easy is it to attach and remove implements from your tractor like a Mower — Tiller or Snow-Thrower? — SHOW ME**
2. **Are the attachments for your tractor Shaft Driven or Belt Driven? — SHOW ME**
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5. **What is the capacity of your tractor's gas tank?**

Ariens welcomes your thorough comparison and is confident that their Garden Tractors will be stand-out quality favorites when you've made it. If you'd like more information about the complete Ariens Garden Tractor line, please write to: **Tractors • Ariens Company • 807 West Ryan Street • Brillion, Wisconsin 54110.**

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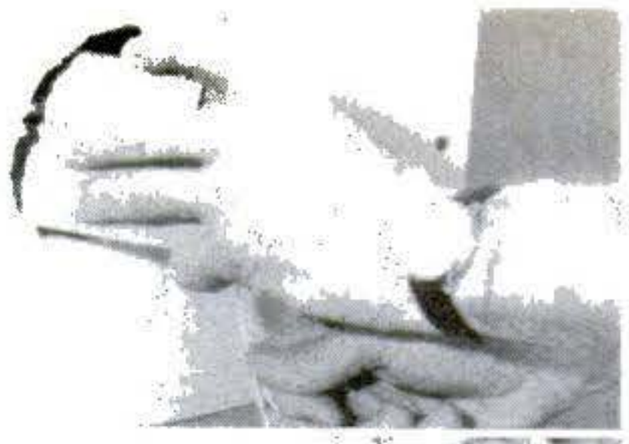

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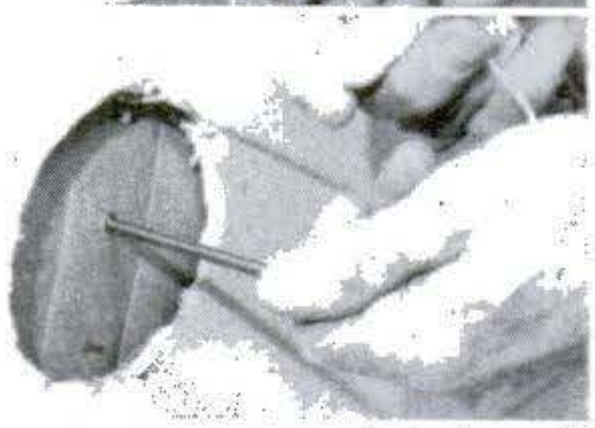

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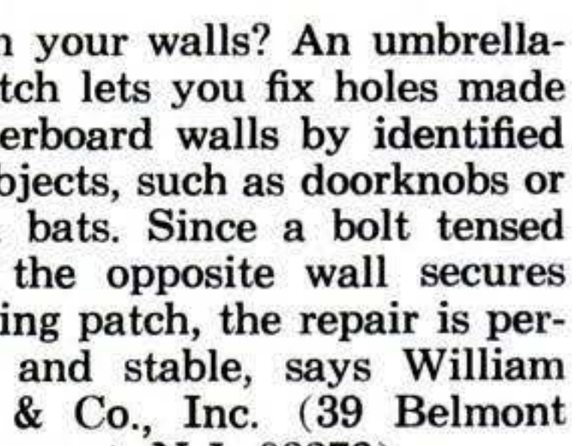

For a sturdy patch job, slip folded patch into hole (1), pull flush with attached string, and secure with bolt (2). Then snip string, spackle (3), sand smooth.

Patch kit
for Sheetrock walls

Holes in your walls? An umbrella-type patch lets you fix holes made in plasterboard walls by identified flying objects, such as doorknobs or baseball bats. Since a bolt tensed against the opposite wall secures the folding patch, the repair is permanent and stable, says William Zinsser & Co., Inc. (39 Belmont Dr., Somerset, N.J. 08873).

The patch is a 7½x7½-in. piece of corrugated board with 4x4-in. honeycombed reinforcement. A Tinnerman nut is fastened between the two pieces. "The Tinnerman nut," says Zinsser's Jack Craig, "keeps the bolt under tension so it can't slack off."

The 3⅝-in. bolt passes through the nut to the back wall, to hold the patch in place. If the bolt doesn't reach the wall, you can replace it with a longer bolt of the same diameter. Or take a piece of wood the size you need and glue it to the wall opposite so the bolt will reach the wood.

Wonder Patches will repair holes from two to six inches. The kit comes in two forms—one with a patch, bolt, patching compound, and sandpaper ($2.98), or a "professional" Wonder Patch kit containing only patches and bolts (six of each for $7.50).—*Laura Wessner*

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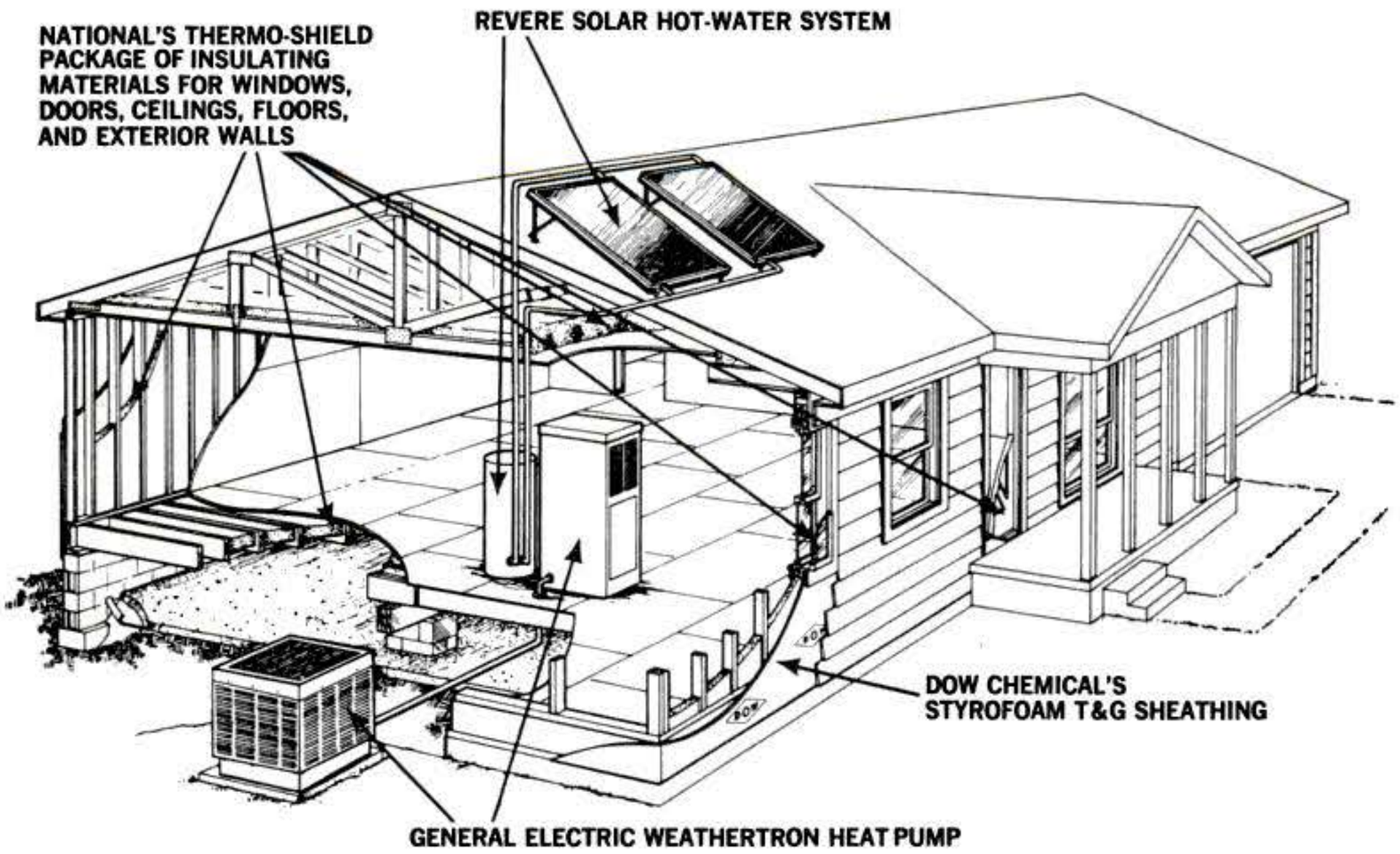
SHOP TALK

By RICHARD STEPLER



Solar-assisted homes for sale

Now it's easier (and less expensive) than ever to own a solar home: National Homes Corp., a panelized-home manufacturer with 450 dealer/builders in 38 states east of the Rockies, has just announced its "affordable solar-assisted home." Beginning this year, National will offer a package of energy-saving features that can be ordered as an option on any of the company's 600 homes. The features (see drawing):

- A solar hot-water system that is claimed to save up to 72 percent of the water-heating bills for a family of four.
- A heat pump that will cost 30- to 60-percent less to operate (depending on location) than an electric resistance furnace.
- Beefed-up insulation: Exterior walls get Styrofoam T&G sheathing plus 3⅝" fiberglass batt; 9" batts in ceilings; 6" batts in floors over crawl space; insulated steel exterior doors; and double-glazed windows. The package also includes "special caulking and other sealing practices only possible because of exceptionally tight tolerances involved in the home-manufacturing process," according to National's president David Price.

In all, the complete solar-assisted package, which adds about $2400 to the cost of the home, should save up to 60 percent on utility bills, says Price. What about payback, you ask?

Price cites an example (all figures compare electric space heating and cooling and water heating with the solar hot-water/heat-pump package): "In Chicago, a family of four living in our best-selling home—a three bedroom model with 1161 square feet of living space—would save $576 annually (on utility bills) if the home were equipped with our affordable solar-assisted package. Our figures indicate the costs of heating, cooling, and water heating would fall from $1248 to $672 per year.

". . . If a home owner in Chicago purchases the house built to current federal standards (without National's package), the monthly principal and interest would be $304, and the average monthly electric bill for heating, cooling, and hot water will be $104.

"For the same model home, upgraded with the National package costing approximately $2400, the principal and interest will be $322 and the average electric bill will drop to $56. This represents a net saving to the homeowner of $30 each month at current rates."

What about going completely solar? Price feels that total solar economics just don't pay off at this time. But he hastens to add that the solar-assisted package "makes sense to the average American today." And National is not just *talking* solar: By the time you read this, the company plans to have 450 solar-assisted homes open to the public. For more information write the Marketing Department, National Homes Corp., Lafayette, Ind. 47902.

Wood as fuel

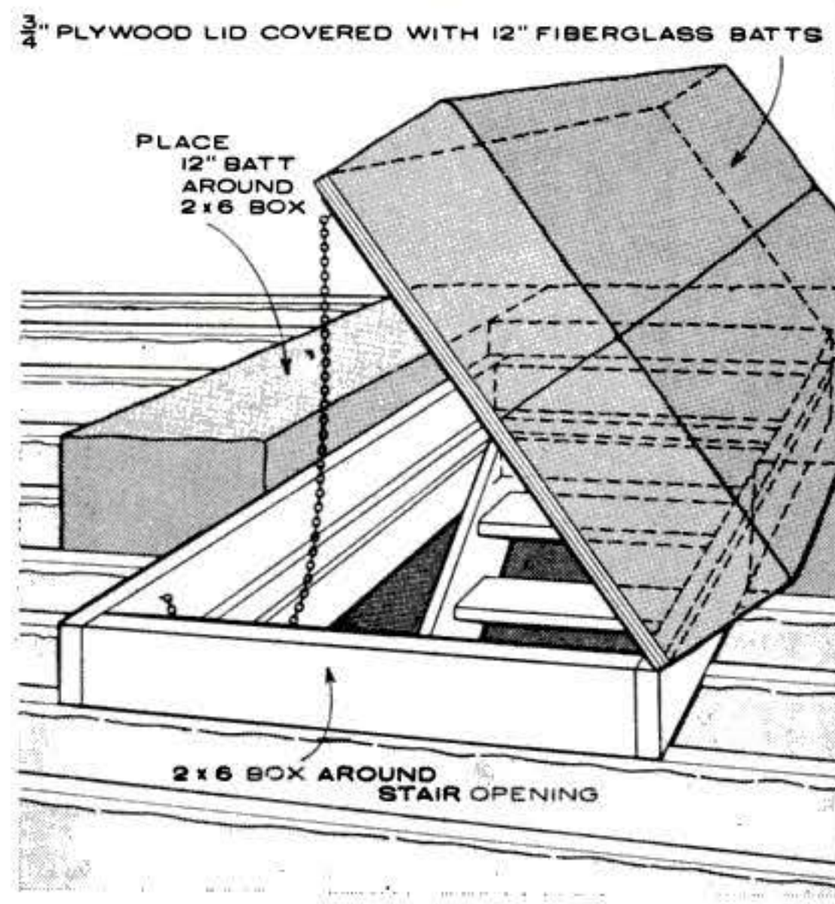
Since our November article, "The Secrets of a Good Wood Stove," we've received several good pieces of literature on the selection, care, and feeding of these appliances. Heating with wood is simply not as straightforward as it may seem, and it's essential that you understand it fully before plunging ahead.

- "Burning Wood" gives advice on culling woodlots, evaluating quality of firewood for sale, storing wood, and designing and cleaning fireplaces and wood stoves. Safe installation procedures get special emphasis. It's 75 cents from Mailing Room A, Research Park, Cornell Univ., Ithaca, N.Y. 14853.
- "The Shenandoah Book on Wood Heat" is a useful catalog available for 50 cents from Shenandoah Manufacturing, Box 839, Harrisonburg, Va. 22801.
- *1978 Woodstove, Fireplace and Equipment Directory,* a 104-page buyer's guide, is $2.50 from Woodstove Directory, 106 Market St., Manchester, N. H. 03108.

Plugging another heat leak

In our November 1977 issue we showed several ways to improve the thermal efficiency of doors ("Heat-Wasting Doors: You Can Plug the Leaks"), including an attic access door. But what if your attic access is via a fold-down ladder? These are often located in a hallway ceiling—a prime spot for heat loss. You can't insulate *over* it because of the ladder, yet the only barrier between your living space and the attic—where temperatures can range from below zero in winter to over 100°F in summer—is a thin plywood panel. Reader Donald Flaster had just that problem. Here's what he did:

"I built a hatch cover for the ladder opening, hinged to allow access, and fully insulated on the attic side. In some homes, especially where two-section fold-up stairs are installed, it may be possible to simply attach the cover to the top of the joists that frame the opening. However in our home (and I



suspect in the majority of homes using pull-down attic stairs) a three-section, double-fold stairway is used. When folded and raised, this type protrudes more than five inches above the joists.

"To solve the problem, I constructed a frame around the opening and attached the hatch cover to it with T-hinges (see drawing). A simple rope stop keeps the hatch cover from falling onto the attic floor when it's opened." PS

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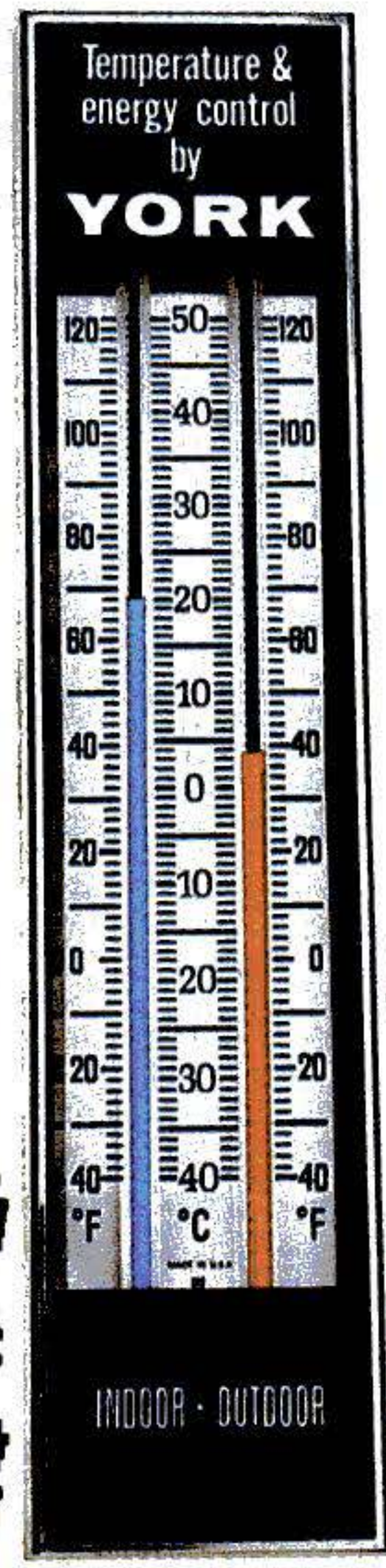

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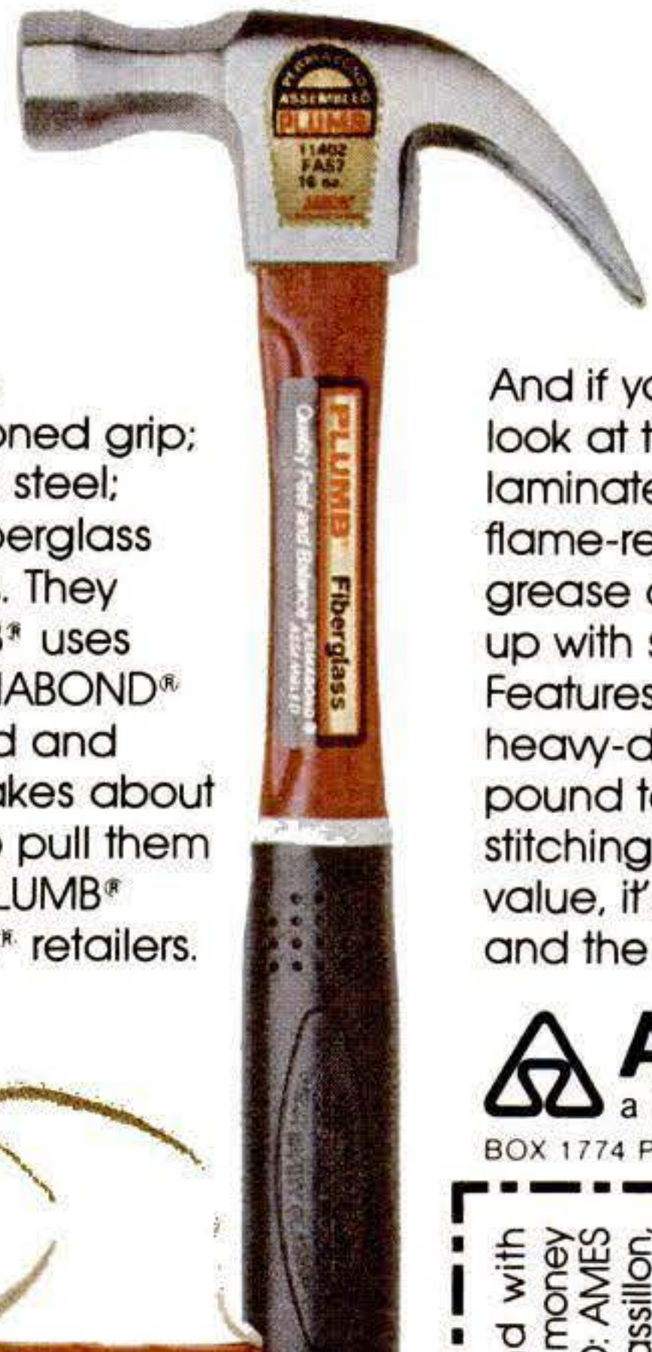

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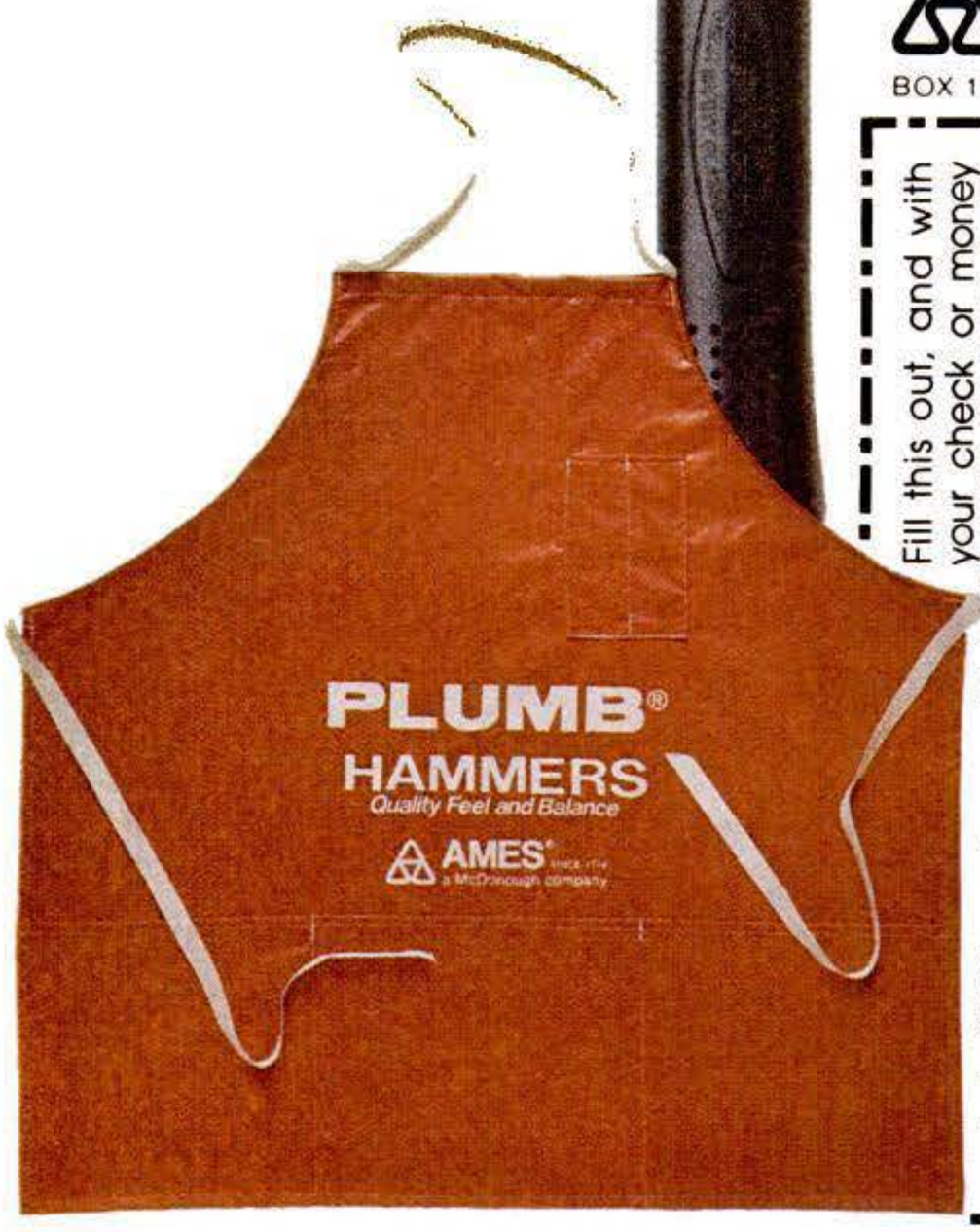

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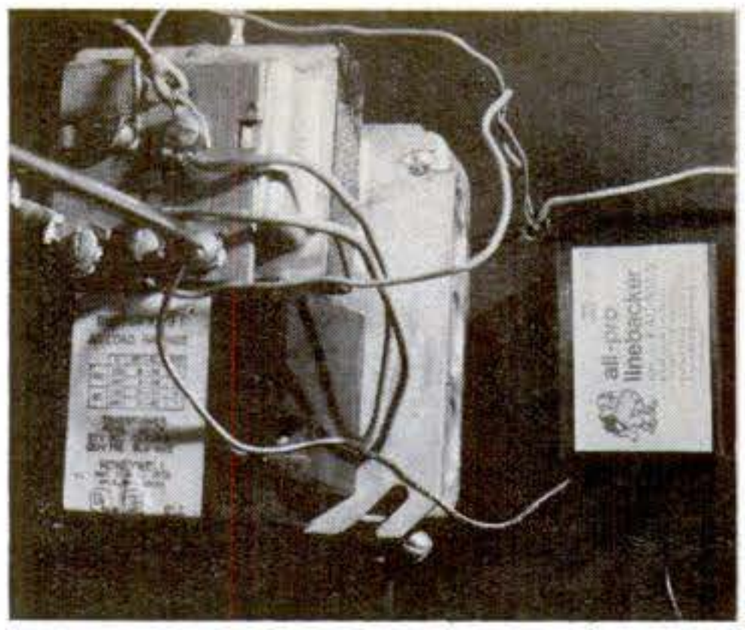

Cycle delay prevents AC compressor failure

Here's an item that every home with a central air conditioner or heat pump should have. Watsco's short-cycle protector prevents costly compressor failure. The device interrupts the circuit to the compressor for five minutes after shutdown, allowing a time delay before restart.

An A/C compressor is basically a pump that forces refrigerant through the system. When it shuts down there is high pressure on one side, often several hundred psi, and very low pressure on the other side. After shutdown, it takes several minutes for these pressures to equalize so the compressor can start again.

The normal cycling pattern allows plenty of time for this. But the compressor circuit often opens briefly due to an electrical storm, a power interruption, or a voltage reduction. In such short-cycle situations, the compressor tries to start again, against the heavy load of unequalized pressures. Usually it can't, and after a few seconds an automatic resetting overload clicks it off.

The problem is, overload doesn't offer total protection. Each time the compressor tries to start, the windings inside heat up. And heat is the major cause of motor insulation breakdown.

Watsco's protector is unique in two ways. First, it needs only two wiring connections to the low-voltage thermostat circuit. Even mounting is easy; it has an adhesive backing that allows it to stick to most surfaces. Second, the five-minute delay begins when the thermostat circuit opens, so it doesn't interfere with the time differential between normal and cooling cycles.

Watsco Inc. (1800 W. 4th Ave., Hialeah, Fla. 33010) sells the EAC-500-5 for $23.—*Evan Powell*

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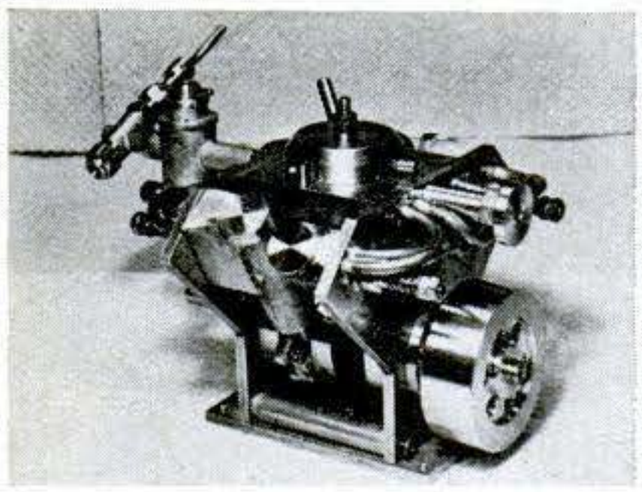

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Gardens without soil

[Continued from page 107]

or disease. "I've tried to grow with less-frequent sterilizations," he says, "and it has invariably gotten me into trouble." Herrington's system of sterilization is simple and safe. He pulls out all the roots from a bed, plugs the end of the drain tube, and fills the tray with water to which he has added a cup of chlorine bleach. This sits for a couple of days, then he drains the bed and rinses it well with water.

Other than planting, pruning, and harvesting, that's about all the work a hydroponic garden requires. Herrington estimates he spends an average of a half-hour a day tending his nearly 80 square feet of growing beds.

Sixty to 80 square feet of hydroponic gardening space is enough to supply most of the vegetables for a family of four. Put them in a greenhouse as Herrington does, and you can grow your family's vegetables year-round. But even without a greenhouse you can reap tomatoes from your rooftop, cucumbers from your patio, and flowers from a sunny window sill.

Next month we'll tell you about a commercial high-rise greenhouse that uses hydroponics in a novel way. And in the May issue we'll report on a handsome hydroponic unit you can buy—to start anything from a mini garden to a farm. PS

MATERIALS AND APPROXIMATE COSTS

This includes materials used for the two growing beds (about 50 sq. ft.) shown in our photos, and the accessories to operate them.

Nutrient pump—5′ head (#2E38N from Little Giant Corp., 3810 Tulsa St., Oklahoma City OK 73112; $30).
Sump pump—low head (#1-AA from Little Giant; $20).
Timer—96 positions per 24 hrs. (15 min. minimum): (Dayton #2E213, dist. by W.W. Grainger, 5959 Howard St., Chicago IL 60648; $50).
Float switch for sump—(made by Penn Automatic Controls; dist. by W.W. Grainger; $8).
¾″ ext. plywood—5 4x8 sheets @ $15
½″ ext. plywood—1 4x8 sheet @ $8
2x4's, 8′ long—6 @ $1.50
5-oz. fiberglass—60 sq. ft. @ 50¢
¾″ PVC pipe (lightweight)—100′ @ 5¢
PVC valves—5 @ $5.70
20-mil vinyl liner—$25
Epoxy-resin filler (putty)—12 oz., $2
Epoxy-resin paint—1½ qt. @ $3.35
Sump (20-gal. garbage can of high-impact plastics)—$10
Aggregate—¾ cu. yd. @ $12 (available at concrete suppliers; or substitute local material).

FOR FURTHER READING

Beginner's Guide to Hydroponics, by James Sholto Douglas. Drake Publishers, Inc., 801 Second Ave., New York NY 10017. $3.95.

Hydroponic Gardening, by Raymond Bridwell. Woodbridge Press Publishing Co., P.O. Box 6189, Santa Barbara CA 93111. $3.95.

Advanced Guide to Hydroponics, by James Sholto Douglas. Drake Publishers, Inc., 801 Second Ave., New York NY 10017. $12.95.

"Quick Growing Hydroponic Gardens," *Better Homes and Gardens*, Nov. 1977, pp. 100-106.

"Hydroponic greenhouse — total growing system," *Popular Science*, Nov. 1976, p. 70.

"Greenhouse Kits for All-Season Gardening," *Popular Science*, Apr. 1976, p. 122-125+ and 138-141.

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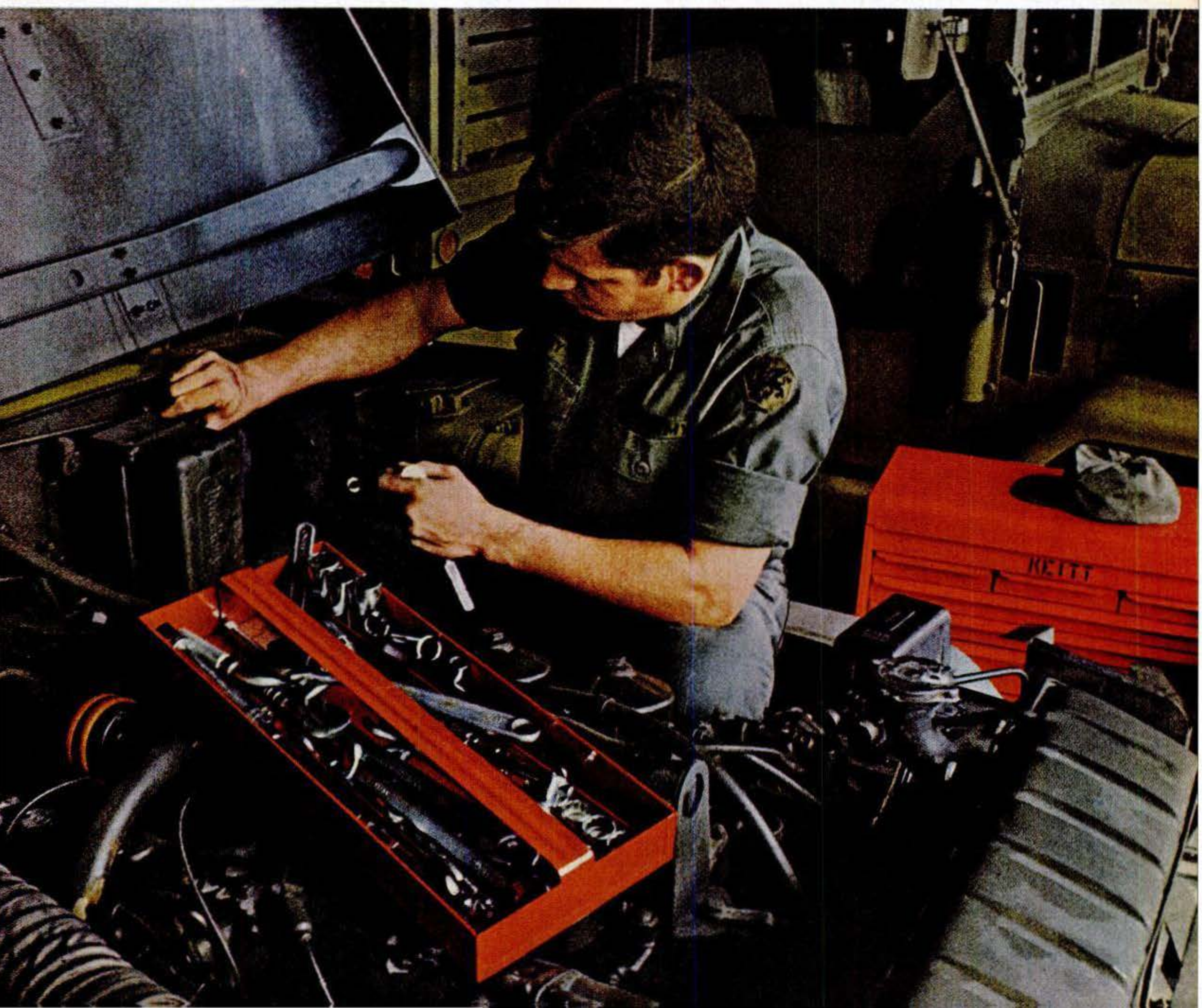

WORDLESS WORKSHOP

By ROY DOTY

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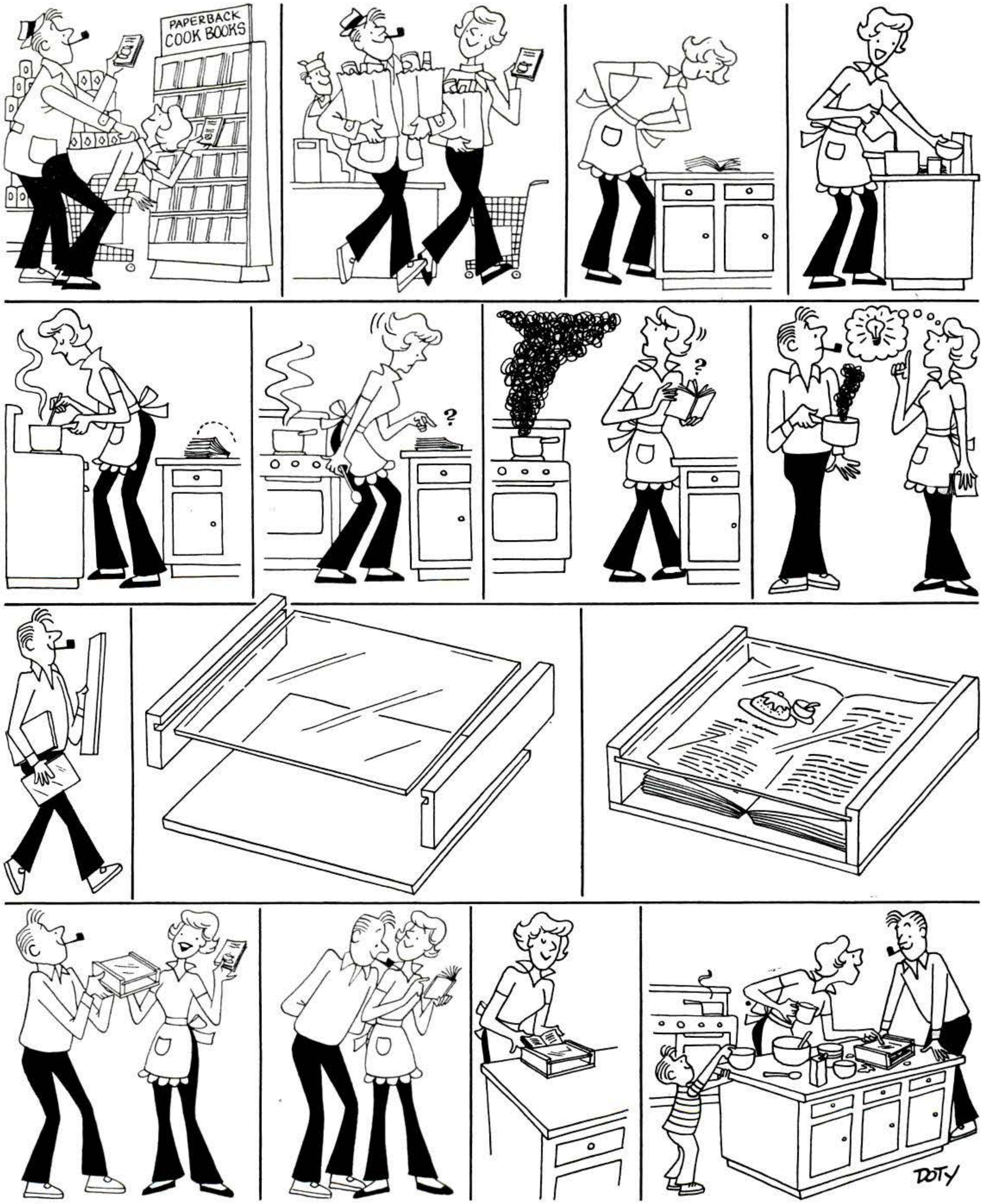

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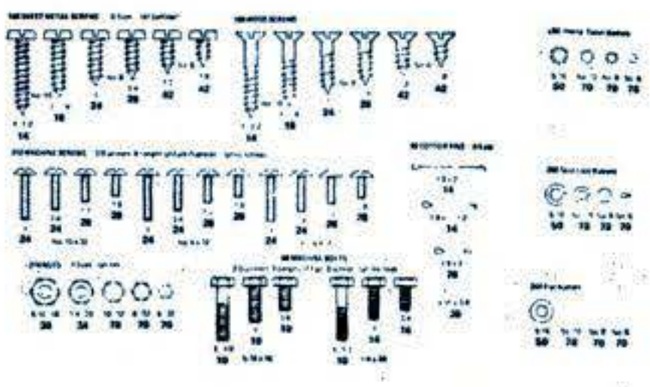

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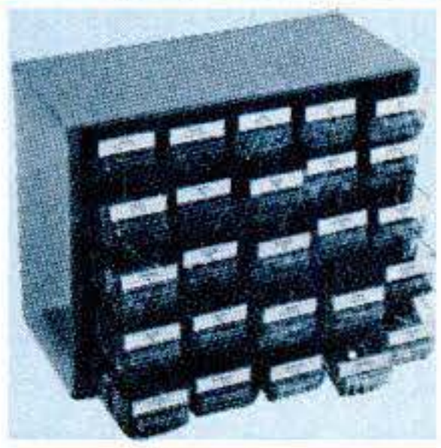

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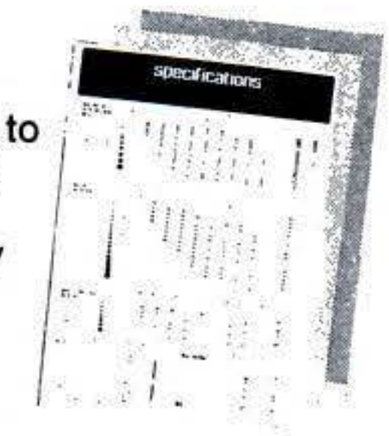

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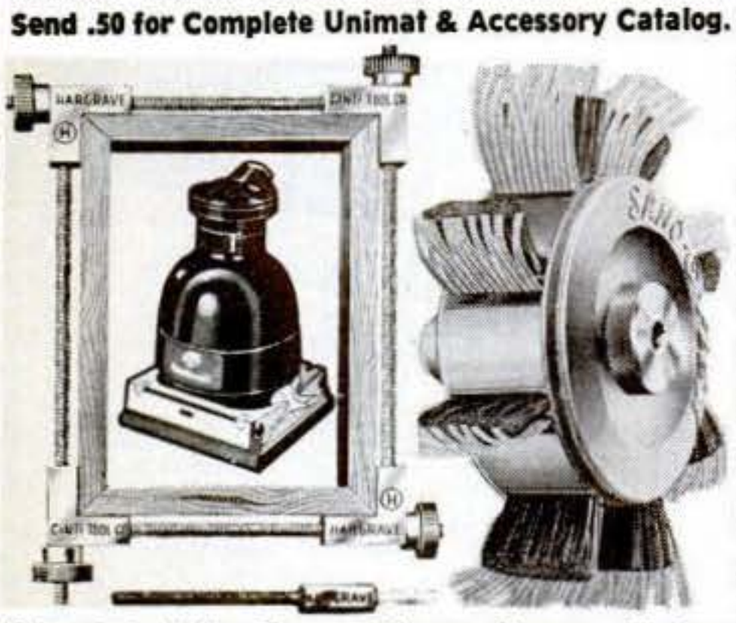

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PS readers talk back

[Continued from page 4]

19th century. While not as dense as hardwood, corncobs have the advantage of a more or less standard and quite convenient size. I'd suggest you use an airtight model with a large firebox (four-cu.-ft. minimum) and a draft control that works efficiently at low settings. It is likewise very important to keep the cobs dry (they are highly hygroscopic), and you may be better off starting the fire with a good bed of hardwood coals.

We'd be interested in hearing if you encounter any special problems with this interesting fuel."

Fire extinguishers

The "PS Guide to Fire Extinguishers" by Charles Salit [Dec. '77] is in error on page 63. A 1-A extinguisher must douse an eight-foot-square or 64-square-foot fire, and the 2-A extinguisher has to handle a 10-foot-square or 100 square feet of panels. A rather common error is to substitute square foot for foot square, but your readers should know the correct size. I enjoy reading your magazine.

Richard L. Jepsen, Extension Specialist,
Farm and Community Safety,
Kansas State Univ., Manhattan, Kan.

Mr. Jepsen is correct. Somewhere between author and printer, eight-by-eight ft. got changed to eight sq. ft.

Warm room

Enjoyed the "Warm Room" [Nov. '77], but I have one question. If you insulate the rafters in the basement, which way should the vapor barrier face—or do you use one?

William Swiger, Bridgeport, W. Va.

Since it's assumed that the Warm Room will be kept toasty when the rest of the house is cold, any vapor barrier should face the interior of the Warm Room. But if you're planning to keep adjacent areas of the house heated to 40° F or so, no vapor barrier is needed in partition walls.

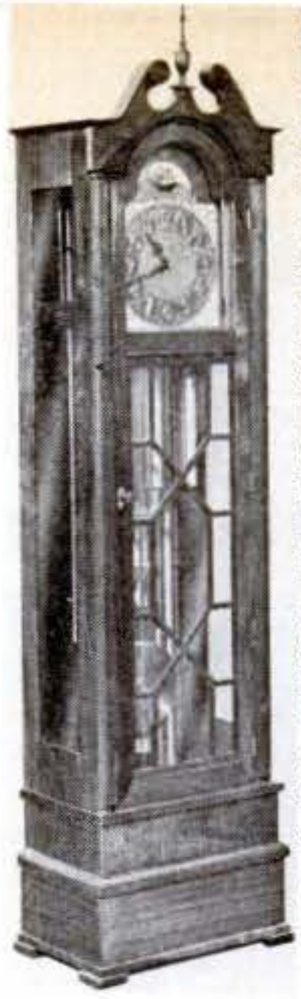
In the "Warm Room" article, the author recommends no windows. This could be dangerous if other means of egress are blocked. Also, most building codes require that "habitable" rooms have windows. I'd recommend installing operating double-pane windows with insulating flaps or heavy curtains.

William H. Bess, Architect
Tillamook, Ore.

More on high-mileage cars

After reading the "914 mpg car" [Dec. '77], I felt compelled to point out that you told us the first-place car and the third- and fourth-place rigs and others —but you failed to mention the second-place vehicle. Also, a news article I read gives the third-place figure as 814

Continued



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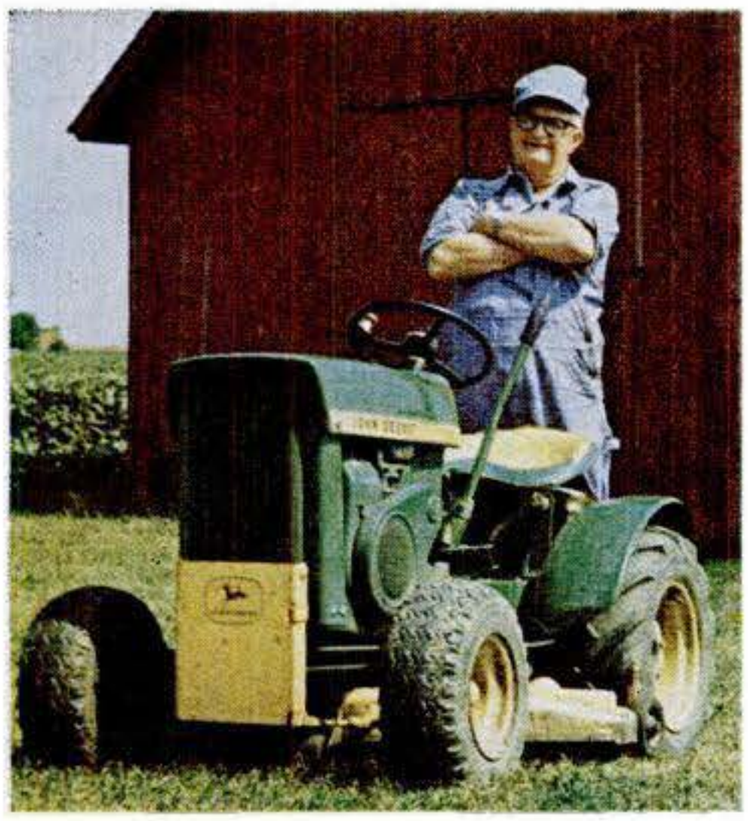
"You'd have to whip me to get this tractor away from me."

Bill Hendrickson, Arthur, Illinois



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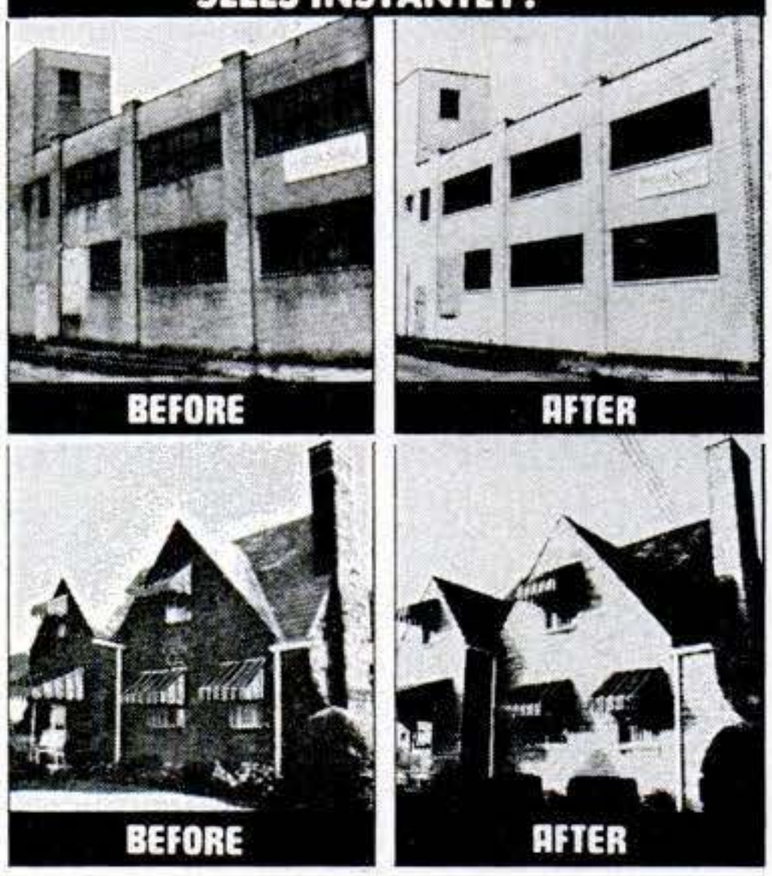

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PS readers talk back

[*Continued*]

mpg Imp., which converts to 678.062 mpg U.S., not the 687 mpg given in your article (possibly figures were transposed). I would also like to point out that Shell's own entry—disqualified from being a winner—got 1298 mpg Imp., which is 1080.234 mpg U.S., or 18 percent better than the winner. I enjoy your magazine very much, but you should be more thorough.

Tommy Dye, Englewood, Colo.

Dave Scott replies: "I reported on the second-place winner, entered by Raleigh, which did 694 mpg, but that photo and caption were cut by the editors for space reasons. The third-place Tempere University entry did do 678 mpg, not 687 as I reported. You're right about the transposed numbers. My fault and I'm sorry. I also reported on the Shell machine, but that too was cut from the published story."

Ice-dam problem

Do you or your readers know of a solution to the ice-dam problem that has plagued the New England area for the past two winters? Ice dams result from melting snow that freezes close to the edge of the roof. This dam builds up with each snow melt, and finally sufficient water is held back to reach a level higher than the top of the first or second row of shingles. The water then gets into the attic and the walls and damages the ceiling, the wall plaster, and both the inside and outside paint. I know of three ways to take care of the problem, and all are either expensive, unsightly, energy-wasteful, or dangerous—and often all four at once. The three methods I know of are: 1) Replace the last two rows of shingles with a rather unsightly sheet of polished metal. 2) Place a zig-zag electric heater cable along the roof edge. The cable melts small tunnels through the ice and water can drain off. 3) Shovel the snow off the roof before the ice dam can form. You must clear the whole roof or the dam will form farther up.

Also, can anyone tell me the effects of increased attic insulation? Will it reduce the snow melt? Or would it be better to let the attic get warmer to melt the snow faster and raise the temperature of the resulting water?

And finally, is there a clear plastic paint that I could use to coat the last two rows of shingles that would smooth the surface so that the ice won't stick?

Fred Lingel, Lynnfield, Mass.

Al Lees replies: "Efficient attic insulation does diminish the problem by reducing snow melt during periods of freezing temperatures (especially at night). It is not really practical to coat shingles—and it would be very costly. If any of you readers have found solutions we'd like to hear from you."

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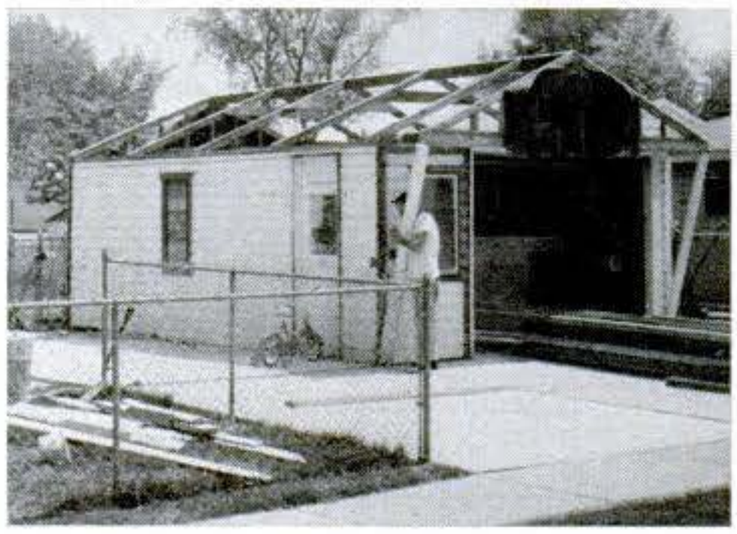
The garage that grew:

You can double the size of a one-car garage

Big 24-by-22-foot double garage (above) sprang from its single-car predecessor (right), which had been built with future expansion in mind. Owners used as much of the original structure as possible—including shingles, doors, windows, and trim—to save time in the renovation and to cut materials costs.

1 These do-it-yourselfers called concrete supplier ahead of time to make sure delivery coincided with their completion of ground preparation. Local code called for a four-inch slab.



2 With slab laid and cured, dismantling begins. Entire roof was removed, one side wall detached and then moved. New lumber needed was ordered and delivered ahead of time.

Save materials—and time—by using as much of the original garage as you can

By MITCH PIERONEK

Need more garage space? Then do as the Jack Pattersons of Grosse Pointe Woods, Mich., did. Saw the garage in two and expand it.

As many young couples do, the Pattersons had built as much garage as the budget would allow at the time: a car-and-a-half size. But with the coming of children, bicycles, lawn equipment, and the myriad of things homes need, their garage had become an obstacle course—with no room left for the car. Wisely the Pattersons had allowed for expansion when the original unit was built. Yard and driveway area posed no problem.

The basic theory was to split the garage in two and expand it, using as much of the old garage material as possible, then filling in the new openings with new construction. One whole wall could be moved over and continue to serve as the sidewall. The front of the garage would be enlarged to allow two garage doors instead of one, and still keep the window next to one of the doors. The rear wall would merely have to be extended 10 feet. The entire roof, however, would have to be rebuilt and repitched according to the building code.

Advantages

Here are some of the benefits of this "expansion and duplication" type of construction:

- Patterns and measurements that

[Continued on page 177]

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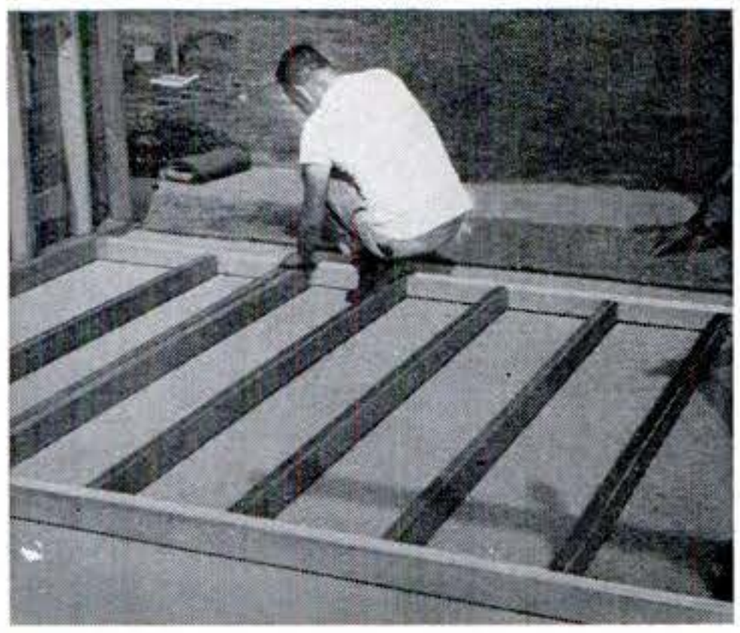
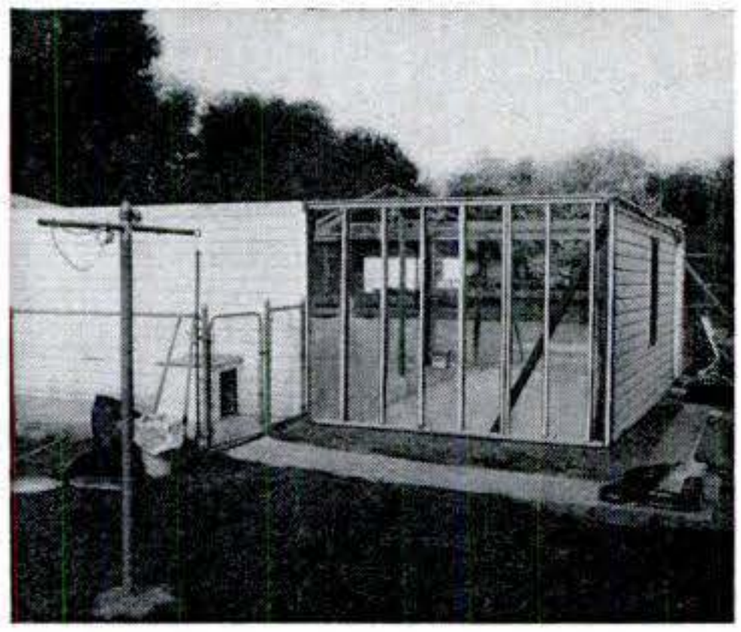
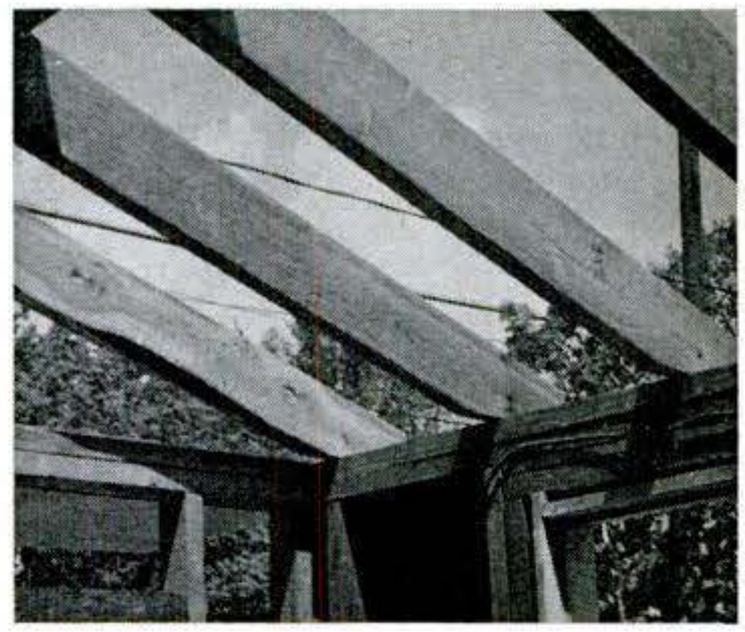
[Continued from page 168]



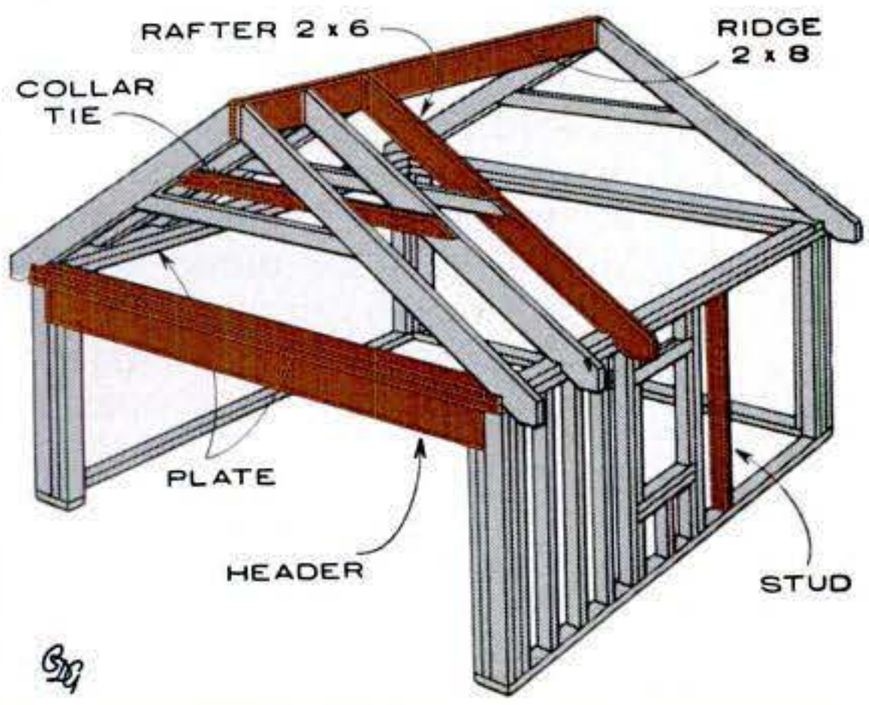
3 **Using existing rear wall** as pattern, rear-wall addition was constructed on the new slab, then lifted and bolted into place. The 10-foot-long section increased width of garage to 24 feet.



4 **Side wall has been moved** and bolted to edge of new slab, and rear-wall addition is in place. Diagonal braces, fore and aft, give structure temporary support.



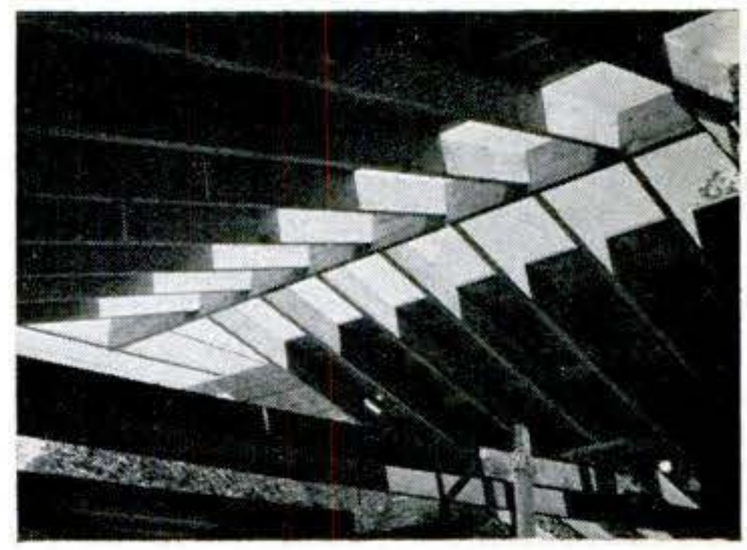
5 **View from interior** of garage shows how 2-by-6 roof rafters were notched and toenailed to plate—doubled 2-by-4's. New, larger roof needed heavier framing than original.



NEW MATERIALS NEEDED

38 14′ 2-by-6's
2 24′ 2-by-10's
2 8′ 2-by-8's
1 10′ 2-by-8
2 10′ 2-by-4's
1 4′ 1-by-6
4 12′ 1-by-6's
4 4′ by 8′½″ ext. grade plywood
1 4′ by 8′⅜″ ext. grade plywood

250 sq. ft. lap siding; six squares shingles; 10 lb. 1″ shingle nails; 7 lb. roof nails; 5 lb. galvanized siding nails; 10 lb. 16d nails; one garage door



6 **Rafters were toenailed** to 2-by-8 ridge board (check your local code for minimum pitch requirements). Original 1-by-6 underlayment was reinstalled, along with some new material.

already exist on one side of the garage can be copied where needed on the new side.

- Costs for new materials are reduced, since much of the old material is reused.
- Construction time is reduced, because whole components—including a wall, window, and door—are reused as is.

How to get started

The Pattersons' first step was to draw up plans and get a building permit. To make way for the new concrete floor, they dug away the lawn area beside the garage. This was done to a depth of four inches, per local codes requiring a four-inch slab. A concrete-pouring company was told to deliver at a specified time so that there would be no delays in construction progress. Necessary new lumber was also delivered at time of use, to prevent piles of wood from getting in the way.

Preparation of the ground and delivery of the concrete coincided nicely. Bolts were imbedded along the edges of the concrete slab so that the new addition could be anchored securely into place as the walls were raised (or moved).

Moving the wall

With the foundation in, the Pattersons began to remove the roof carefully so the shingles could be reused later. When the entire roof was removed, the side wall was freed from the rest of the garage. To facilitate moving this wall, 2-by-4's were laid on the floor to act as slides; the wall was detached and slid along them—with some neighbors helping.

Four-inch-wide strips of treated tar board were then laid along the outer edges of the concrete slab with the imbedded bolts protruding through them. This was done to keep moisture from entering the wood walls and to act as an expansion strip. The newly moved wall was placed atop these strips and bolted into place.

The new rear-wall section was built on this slab. When it was completed, the wall was raised into place, bolted to the slab, and nailed to the adjoining walls.

Next, the Pattersons installed the framing for the new garage door, using the existing door frame as a pattern. They placed header and cross ties according to code. Here, they had to make sure that the walls were straight so the roof rafters would fall into place properly. The garage must be squared before the rafters go up. To do this, you run a tape measure diagonally across from one corner to another; then do the same with the other two corners, making sure both distances are the same.

The roof framing was erected at pitch according to code. Collar ties were installed every fourth rafter, also according to code. The Pattersons reinstalled the original roof underlayment—1-by-6's—and supplemented it with new material to make up for the larger roof area. When shingling the roof, they mixed the old shingles with new ones to give the roof an even overall coloration.

A new garage door that matched the old one was then hung, using the existing door as a guide to installation. Repainting the entire garage completed the transformation. PS

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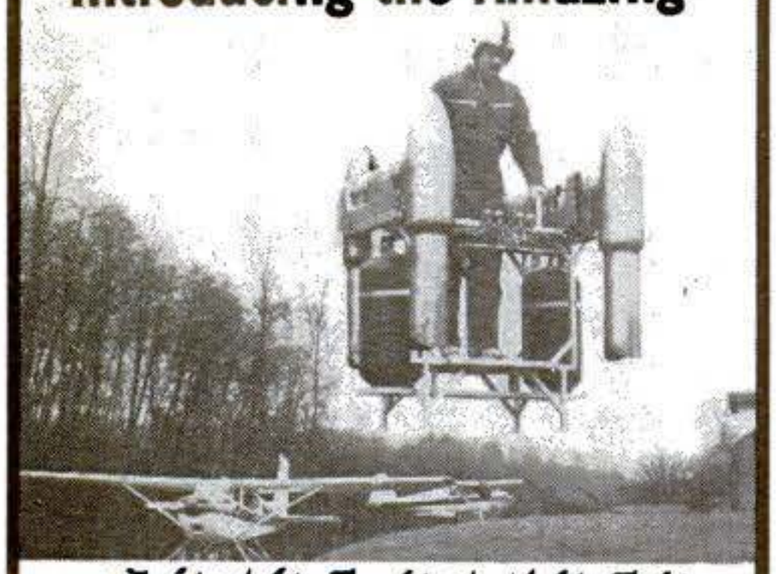

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Home cure for a damp basement

One of the best features of our new home was its large basement. I had big plans for using it as a workshop and den, but my enthusiasm was dampened by the spring rains. After every shower the concrete walls were moist and small puddles collected on the floor.

On close inspection, I found what's diagrammed in the section below. The drain tiles were supposed to drain water to a sump before it rose to crack or seep through the floor. Yet these tiles never released a drop of water, despite my dampness problem.

So I called in a dry-basement contractor. His diagnosis: rain water stacked up in the cores of the concrete block. These standing columns of water were trapped by the mortar seal against the footing, and by the sealer coats on the inside and outside faces of the block.

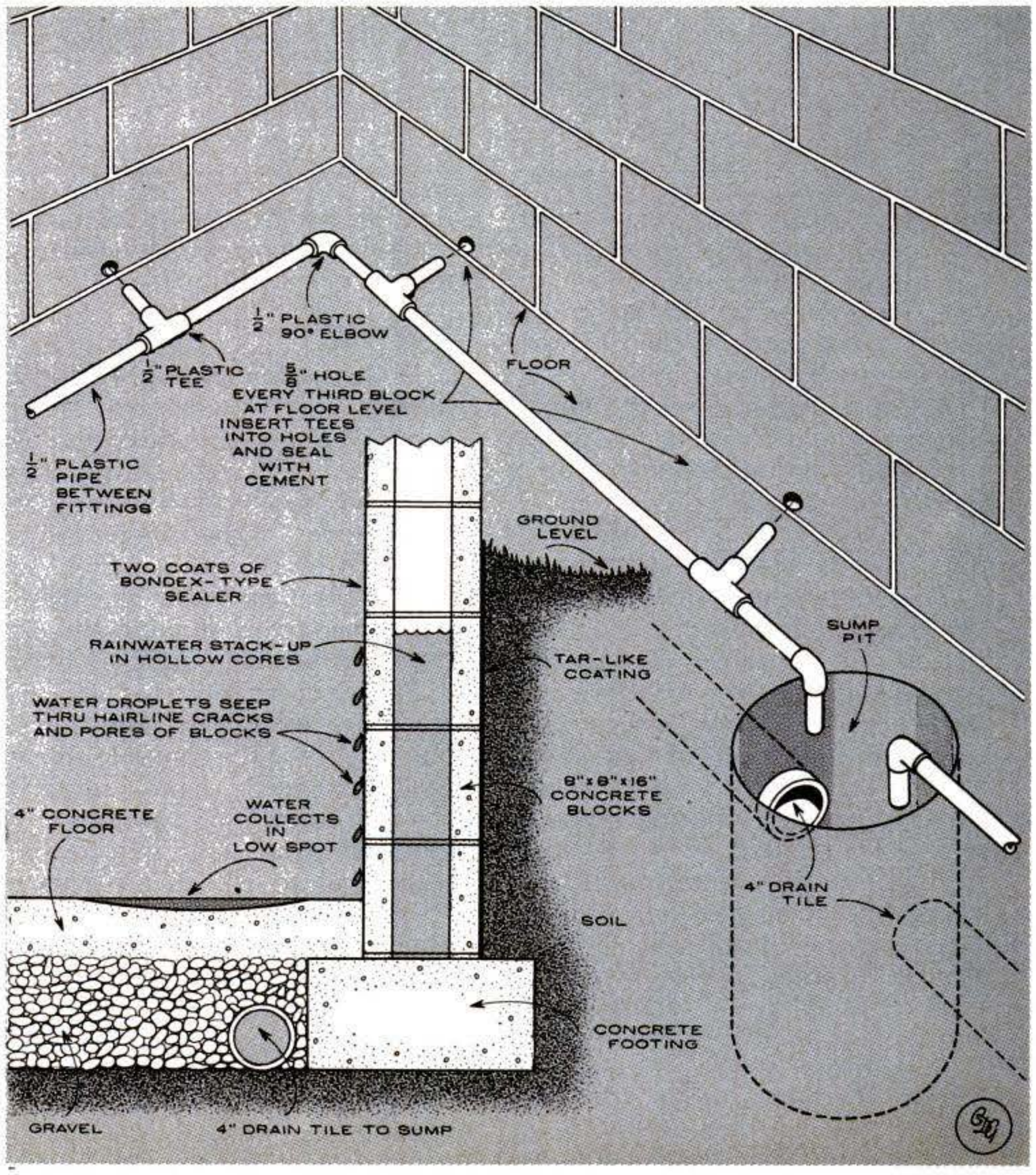
The dry-basement man could free the water by digging a perimeter trench outside my foundation to lay new drain tile—but this meant tearing up shrubbery and tunneling under a concrete patio. I elected to solve the problem myself for a small investment and a few stiff muscles.

Using a 5/8″ masonry bit, I punctured the core of one floor-level block. I thought I'd struck a natural spring. Backed-up water shot out in a long stream and ran steadily for 45 minutes.

I then drilled every third block, for a total of 40 holes. I seated a 1/2″ plastic T into each hole with quick-setting hydraulic cement.

Then I cut plastic pipe to join the T's, with 90-degree elbows at the corners. Dipping the semirigid pipes in hot water eased assembly. The pipe drained to the sump pump (see diagram). For a finished baseboard look, I poured a cement curb around the pipe.

Soon an all-night downpour tested my system. First, a trickle of water; then the sump pump kicked in. The pump worked all night at 15 minute intervals—a great lullabye for a harried home owner.—*Edward M. Lisowski*



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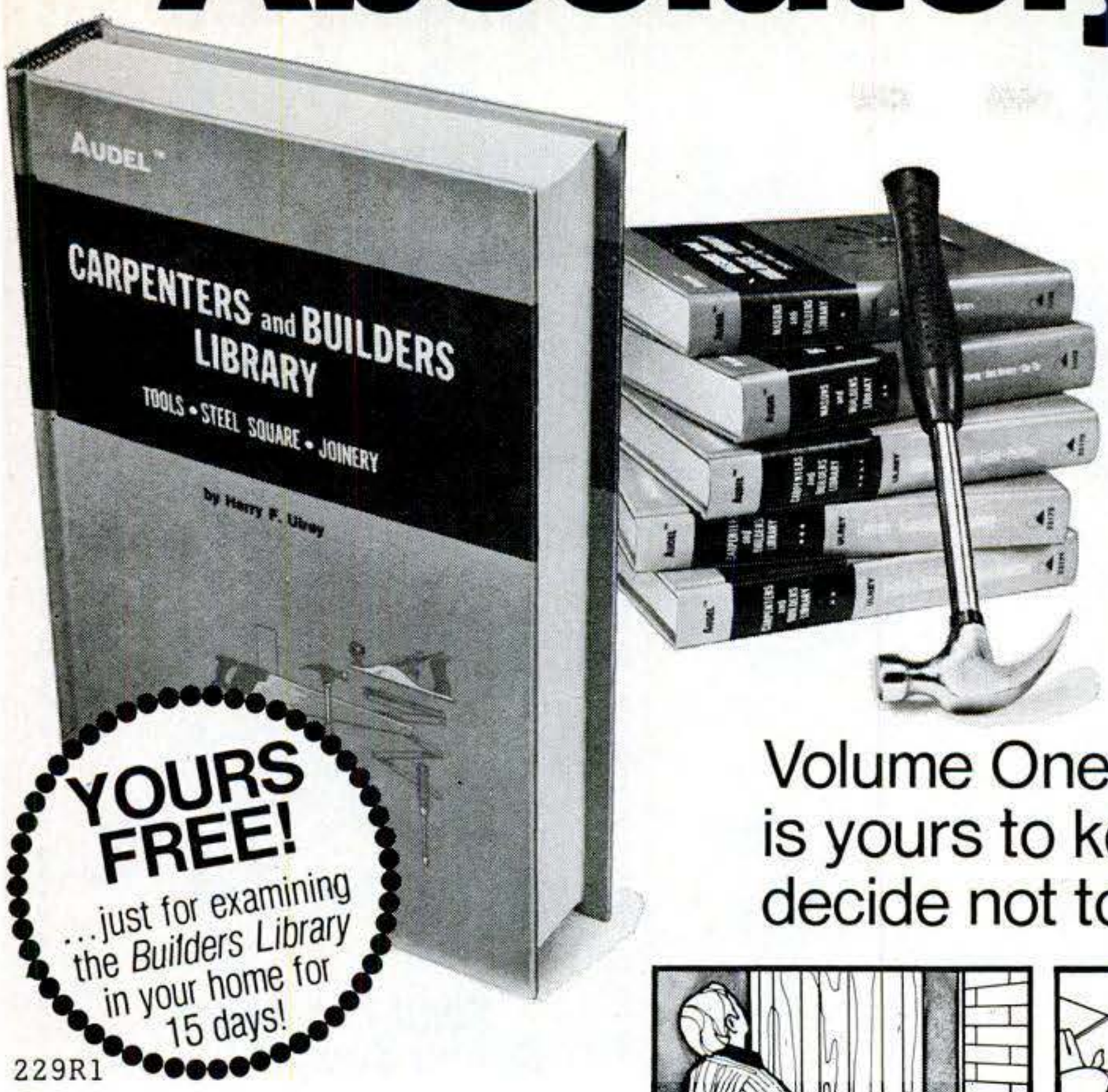

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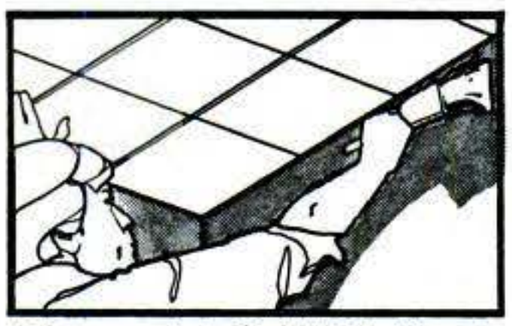
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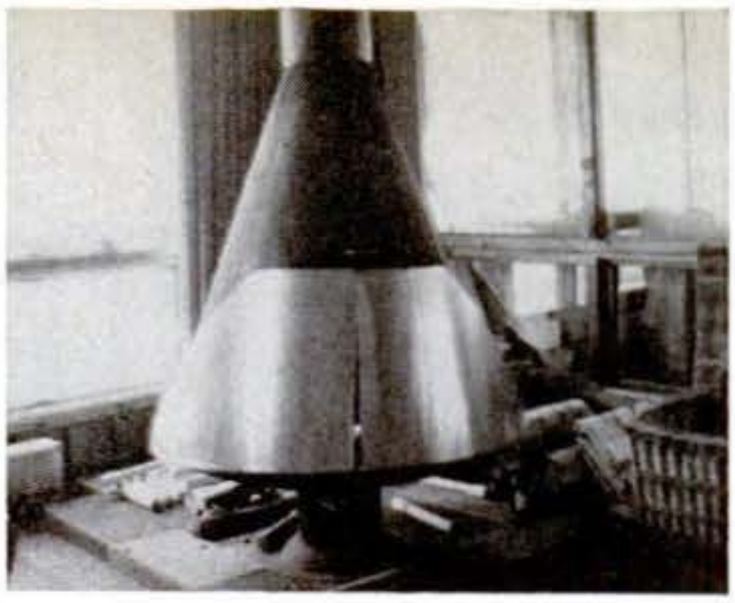
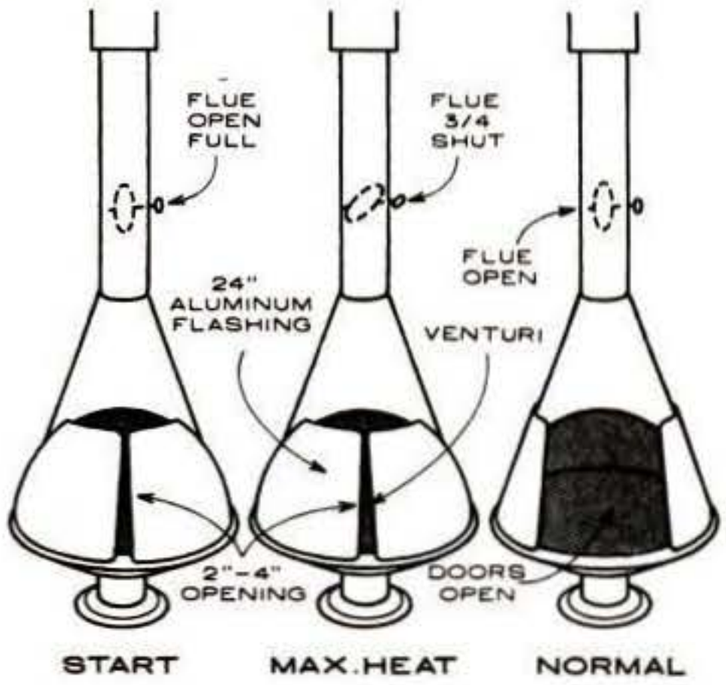


Aluminum-flashing doors nestle on lip surrounding conical fireplace. Triangular slot channels oxygen to fire.



Door openings are coordinated with damper as shown, depending on stage of fire and the need to eliminate smoking.

Draft-control doors
for a conical fireplace

Improving airflow in a conical fireplace is easy with these draft-control doors I fashioned out of a length of 24-inch aluminum flashing. I sized the metal to match the opening in dimension and curvature, and cut on a bias to create a two-to-three-inch-wide triangular slot at the bottom (when the doors are nearly closed). This slot provides a venturi for air drawn into the bottom of the cone and under the grate. Air velocity is increased and oxygen is channeled more directly through the heat source.

While kindling, or turning up an existing fire, the damper must remain open. Once the fire is well under way, with a good bed of hot coals, I adjust the slot and damper as shown in the drawings above to generate more heat. In order to minimize heat loss via the flue, I close the damper almost fully and draw the doors together just until the fireplace stops smoking.

A good chimney draft is dependent upon adequate flue height and diameter, and sufficient airflow. If chimney size is not ideal, the doors can help prevent excessive smoke.
—*Joseph W. Doherty*

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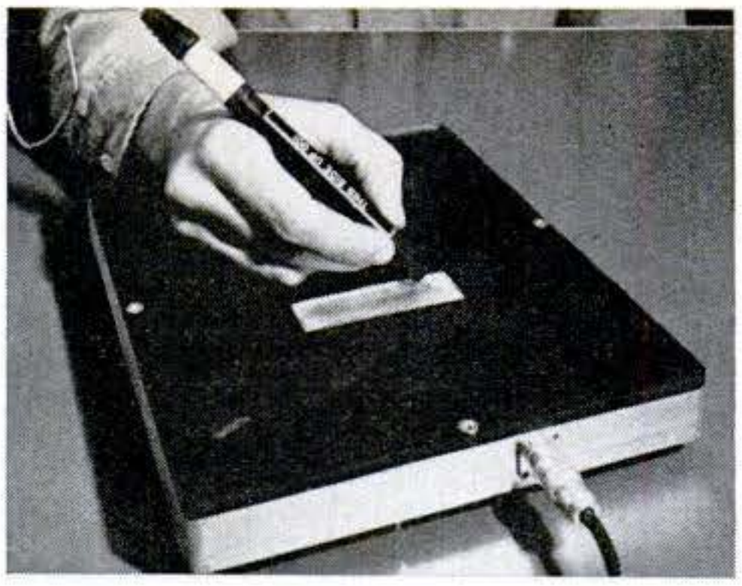

Ask the manager of a nuclear-power plant about his major concerns—chances are that terrorism and sabotage are high on the list. To help control access to classified areas, Sandia Laboratories (Albuquerque, N.M.) has developed a specially instrumented ballpoint-pen-and-tablet set that identifies a person by his signature.

The pen/tablet set was developed on the premise that signatures vary in the amount of pressure and speed that are applied to certain letters.

"It's a medically proven fact that hand muscular movements differ among individuals," Sandia's Rod Geer told me. "These muscular movements form a handwriting pattern that is unique to each person. Though a forger can reproduce the appearance of my signature, it's impossible to duplicate my handwriting pressures and movements in fine detail."

To record these identifying characteristics, the pen/tablet set uses piezoelectric transducers. These devices contain a ceramic material that generates voltage when pressure is applied. The transducers convert handwriting movements and pressures into electrical impulses that can be processed by a computer.

The pen tip has two pairs of transducers: One records horizontal movements (crossing a "t"), the other records vertical motions (forming the stem of a "p").

Three pairs of transducers in the tablet generate signals that vary in strength according to the amount of pressure applied when using the pen. The mix of signals from pen and tablet creates a unique electronic profile of a person's handwriting, just as fingerprints or voice prints are used to identify individuals.

Sandia says the system is compact, rugged, and simple to build and service. Many parts—the pen refills and piezoelectric transducers, for example—are commercially available.—*David Hoover*

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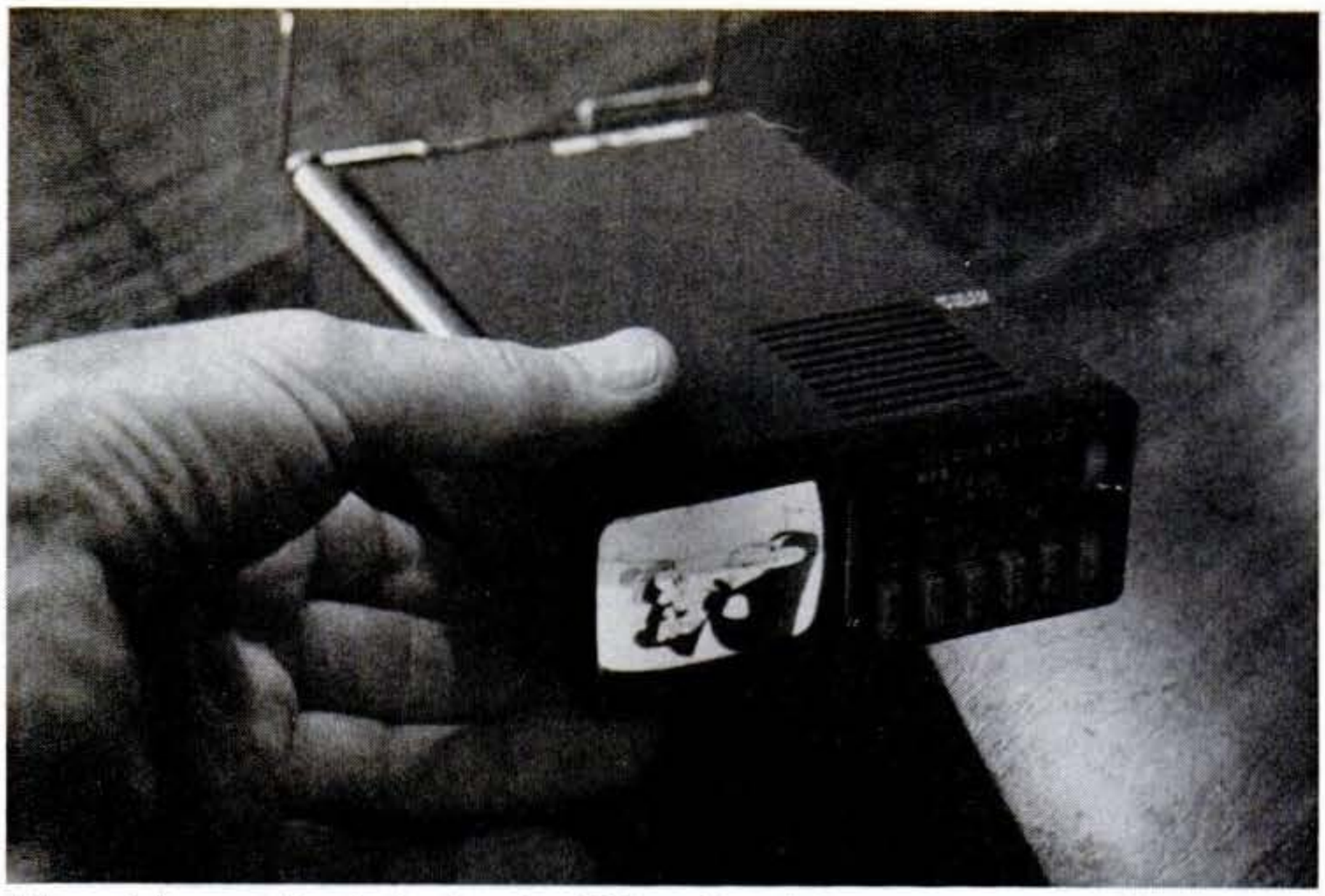

Microvision set is six by four by 1½ inches, and weighs 26½ ounces. It's designed for one-person use, but two can watch at once—if they're close friends.

Tiny television has a two-inch screen

What's it like to look at a TV screen the size of a 35mm contact print? To find out, I spent a week with Sinclair's two-inch television set. At first, the British-made Microvision's picture looked like an animated postage stamp. But soon my eyes adjusted. I watched Spiderman while riding around London, the news while sipping beer in a pub, and a football game while strolling along the Thames.

Holding the set at reading distance gives the same effect as a portable TV at six feet away or a 24-inch model at 12 feet. That's what Sinclair claims. But although large titles are clearly readable, small print is hard to make out. Still the fine-grain black-and-white picture is clear in most places, and an attachable visor can shade the screen for outdoor use. The built-in speaker puts out only 50 milliwatts of audio—not enough to combat background noise. However, a plug-in earphone allows public viewing without disturbing, or being disturbed by, neighbors.

This pocket TV is an electronic marvel. Sinclair designed three integrated circuits that make the miniaturization possible. Special VHF and UHF tuners permit push-button selection of U.S., British, or European transmission standards. Two antennas fold into the metal cabinet: a telescopic rod for VHF and a UHF wire loop that swivels on a coil-spring hinge. Ultra-low-power consumption comes partly from electrostatic deflection circuits (instead of the usual high-current magnetic deflection) and partly from a low-current heater used by the picture tube, which also helps produce a picture nearly instantly when the set is switched on. The only thing missing in the well-thought-out design is a stand for convenient tabletop viewing.

The price of the Microvision is not tiny—$395.—*David Scott*

Accessories kit makes this a go-anywhere set. Included are battery chargers for 110V and 220V (with appropriate plugs) to recharge internal nickel-cadmium cigarette-lighter cable adapter for operation in car, external battery pack for 40 hours of viewing away from plug-in power, carrying case with bag for earphone, visor.

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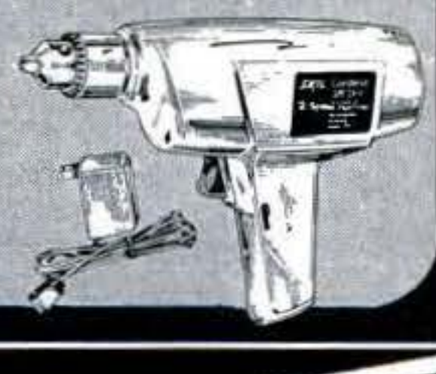

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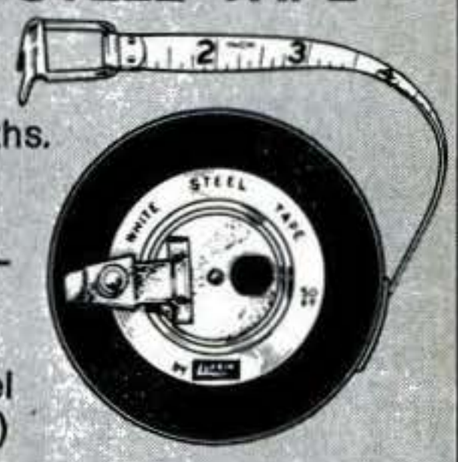

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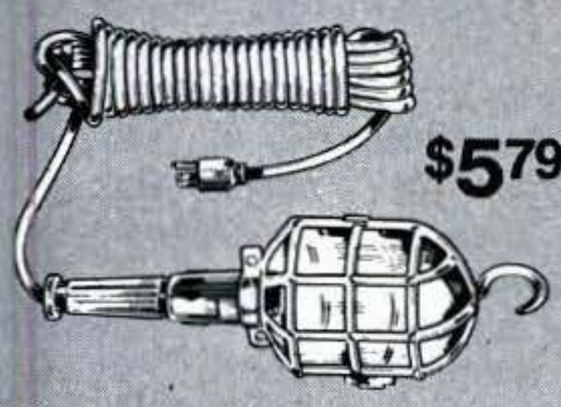

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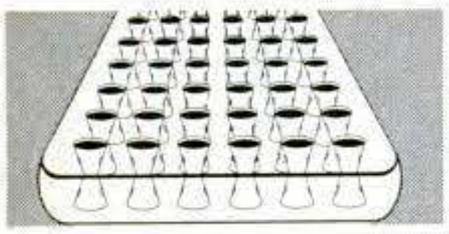

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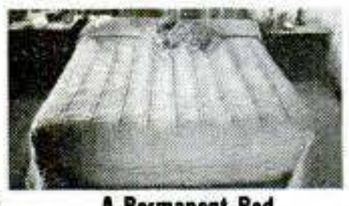

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[Continued from page 80]

tween launch cost and payload cost. Not the weight ratio."

Kayser's concepts and engineering solutions are so revolutionary that, as Kurt Debus said, "my colleagues at NASA were stunned." Kayser's innovative and commonsense commercial approach was also what motivated Debus to join the project as OTRAG's chairman and to contribute his own skills.

Freight-only launcher

I asked Debus why no one—particularly at NASA—had ever come up with something similar before.

"All previous systems," he said, "were either developed for military purposes and adapted to peaceful uses, or they were built for manned missions and required a whole arsenal of safety-oriented redundancy. This launcher is designed purely for freight."

"I haven't invented any new laws of nature or new mechanical principles," says Kayser. "But I had to keep turning the screw and looking for cheaper solutions. So I glanced around at other systems and asked two basic questions. What do they have and what don't they need?

"Well, they have complicated technologies such as rotating machinery, hydraulic and pneumatic systems, seals, pumps and complex electronics which are not only expensive but contribute to high failure rates. To avoid the failures, even more technology is built into them—redundancy.

"If you can eliminate all that, you can reduce the failure rate. But then, to use one example, you also cannot gimbal your engines. Reasoning like that led us to the idea of throttling."

Looking back, Kayser mused, "It has been like a chain reaction with one solution to a problem creating different problems, which then dictated new solutions."

Associates say Kayser's engineering genius is surpassed only by his business acumen. Money was and remains the common denominator. He wanted no high technology for the sake of technology and frequently had to pull himself and his engineering team back to earth.

That team is astonishingly small, for OTRAG is still a tightly run organization.

The company has fewer than 50 employees in Germany, of whom

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more than half are engineers and technicians or mechanics who build tank units and engines at the Stuttgart assembly plant, plus 300 Zairians who are working at the launching site.

To keep costs down, Kayser vetoed flying a regular tower to Zaire for that first launch last May. Instead, carpenters at the site made one from tree trunks.

"We only needed it to hoist up the nose cone with a winch," he explained.

Equatorial launch pad

The choice of Zaire was dictated by several factors. OTRAG wanted equatorial launching facilities and needed a sparsely inhabited test range. Neither was available in Europe. Ship launching, though once considered, was ruled out as too expensive because of the need for auxiliary and supply vessels and too subject to weather conditions. Moreover, the UN space treaty prohibits private exploitation of space without the sponsorship of some government.

Kayser negotiated with several countries, including Brazil and Indonesia, but Zaire's President Mobutu, recognizing the commercial prospects as well as the prestige factor, was the first to react. He allocated the huge plot—inhabited by some 10,000 bushmen—in the southeast corner of the country adjacent to the borders of Zambia and Tanzania, on a rental basis with a 25-year lease.

The launch site is on a 4000-foot-high plateau overlooking the Luvua River, a tributary to the Congo. It has a climate "like Switzerland in summer." Because of the plateau's shape, Zairians call it "The Split Behind," and Kayser is referred to as "The white friend who puts fire into heaven." Since selecting the site in the spring of 1976, OTRAG has set up its launch pad, control bunkers, workshops, housing facilities, and community center, and has laid out an airfield with a 7000-foot runway to accommodate company transports that ferry in supplies and rocket modules, machinery, propellant, and electronic gear.

But meanwhile the whole project has become one of Africa's hottest political potatoes because Mobutu's neighbors, particularly Moscow-oriented Angola, accuse him of paving the way for neocolonialism and suspect him of building up a military missile potential. Even the Kremlin has gotten into the act, with Soviet President Leonid Brezhnev decrying the OTRAG project in a recent speech, and Communist-bloc and some Western media have hinted darkly that West Germany is building up a rocket strike force under an OTRAG cover.

"Obviously you could carry an atomic bomb in an oxcart, too, but there is really no way our vehicle could have military value," Kayser insisted. "We're much too exposed and vulnerable to be a credible threat to anybody."

The argument isn't likely to persuade the critics of the Zaire installation, however, and given the current controversy as well as the general political instability of African countries, Kayser says he will look for a second or third launch site in South America or in Asia. He hopes for "broader international backing, politically."

By the time the space truck is operational, total investment, including the launch site, rental commitment, and establishment of a large production facility for assembly of modules and components, is expected to range between $220 and $350 million—at least ten times more than has already been spent.

But Kayser and Debus are confident they can raise the money from private investors, especially since they will not need it all at once. They are also certain—despite persistent skepticism in European, and particularly German aerospace circles—that their rockets will function as predicted as their configurations get bigger.

Kayser expects OTRAG to be launching 12 satellites annually between 1981 and 1990, and estimates that given the large profit margin all investments will have been recouped after the 25th launching.

"But we can make out financially even if we get only three shots a year," he said confidently. "After all, I didn't set out just to build a better mousetrap, but also a cheaper one."

Can his "cement truck" really do the job of a Rolls Royce? Pointing to OTRAG's modest technical depth and the complexity of orbital injection and course control, many aerospace experts are doubtful. But they'll keep watching developments closely. After all, some great technical advances have grown out of just such dramatic—and unconventional—ideas. PS

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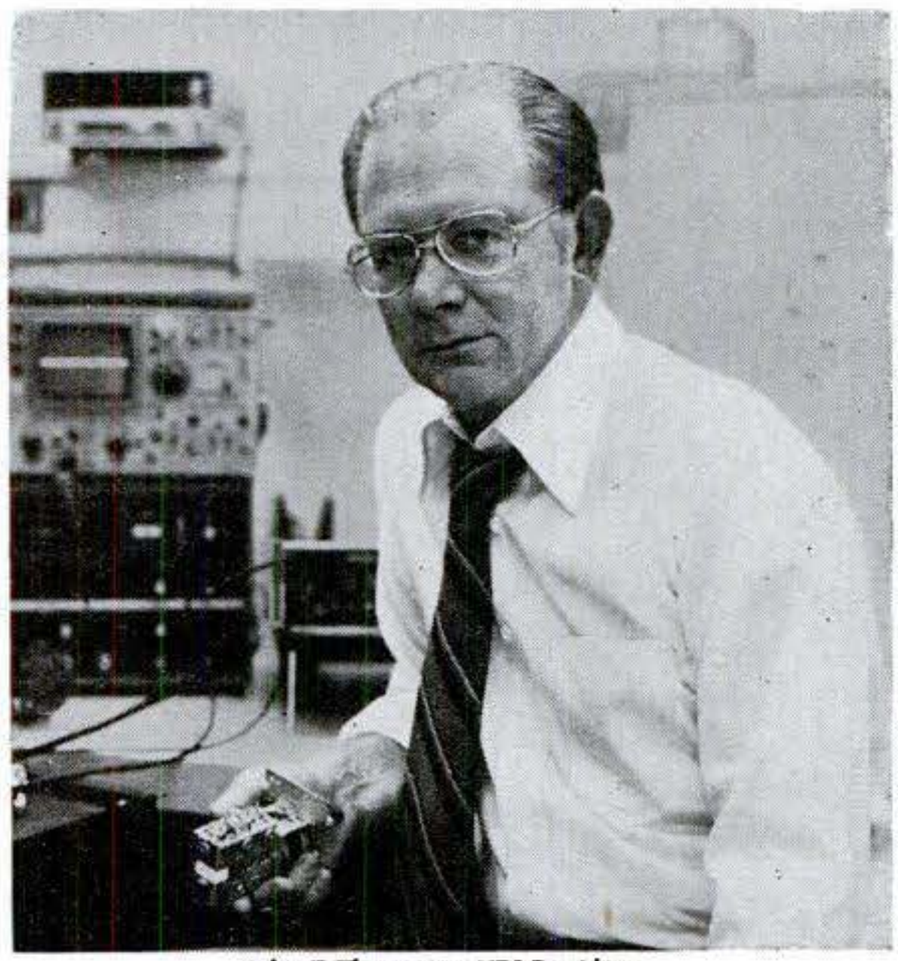

John F. Thompson, NRI President

Maybe you don't believe that we can actually teach you to service TV and audio equipment by mail. Yet here at NRI, we're doing it every day. Helping people to bigger and brighter futures. Let me tell you why the NRI way works so well... and challenge you to put us to the test.

One of the secrets of the success of this school is the fact that its founder, J.E. Smith, was a teacher. So, when he originated his first course in radio over 60 years ago, it was carefully designed with training in mind. And that principle has guided us ever since. In every technical course we offer. Today, every aspect of our courses in TV and audio servicing are student-oriented to make learning as fast and as easy as possible.

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And Mr. Smith taught us something else, too. Not to go too fast. So, our courses have what we call "bite-size" lessons. That's another way of saying that they're easy to digest. Big enough to cover a specific subject thoroughly, but not so much that it'll overwhelm you. Written clearly, without a lot of gobbledygook. And we keep in mind that you're learning at home, so you take our lessons at your own pace. That way, you can learn in your spare time without interfering with your present job or eating up too much of your family life. Of course, if you want to move ahead faster, we're behind you all the way. The point is, it's your choice.

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One of the ways we back you up is with a fully-qualified staff of professional instructor/engineers. They're there to help you when you have a problem with any aspect of your studies... lessons, theory, bench training. And because most of them actually helped plan your lessons and designed your equipment, you'll get answers right from the horse's mouth, answers that are clear and to the point.

I might add that these are not a bunch of ivory-tower professor types. In between checking your lessons and giving you personal help, they're busy keeping up with the state of the art, designing new equipment and revising lessons to get you ready to handle even the latest equipment. As a case in point, take the audio equipment we added to our course recently. Not just stereo, but *four-channel.* Maybe a little exotic, but when a servicing problem like this hits your bench, you're ready for it. It's the kind of thinking and planning ahead our founder would have liked.

I Dare You To Do It

Now you might think I'm bragging a little too much on how good NRI is, and maybe I am. I'm mighty proud of our accomplishments. But the proof of the pudding is in the eating... how our training works in preparing people for actual jobs. So I'm inviting you to ask the only people who can give you a totally objective answer, professional TV and audio technicians. And here's my bet. Just look in your yellow pages for a couple of TV repair shops, ask to speak with anyone who actually does the repair work, and ask him what he thinks of NRI. I'll bet he says, "Do it!"

I'm not really sticking my neck out, because I know something you may not. Almost half the TV servicemen working out there have taken home-study courses. And among them, it's NRI more than three to one! Ask the pros on the firing line and three to one they'll recommend NRI to you as their first choice. I'll be happy to send you a copy of the national survey that proves it.

Why do the pros like us? Because NRI works. You take it at home so you don't have to go to classes. You take it in your spare time, so you can hold down your job while you get ready for your step forward. And you take it easy, because our bite-size lessons make it easier, let you set your own pace.

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And to top it off, NRI's equipment is exclusive. We design most of our own, so it's not somebody else's hobby kit or a stripped-down and mostly assembled commercial unit. It's designed so you really learn as you build, designed to give you lots of honest bench time, designed to give you the satisfaction of finishing up with a fully operable, top-quality unit that's comparable to any commercial set on the market. But you built it... you learned something on it! That's J.E. Smith's philosophy again.

It all boils down to the fact that we've aimed our training at a very practical goal... giving you the skills you need to move ahead in a rewarding career. Or even to have your own full- or part-time business.

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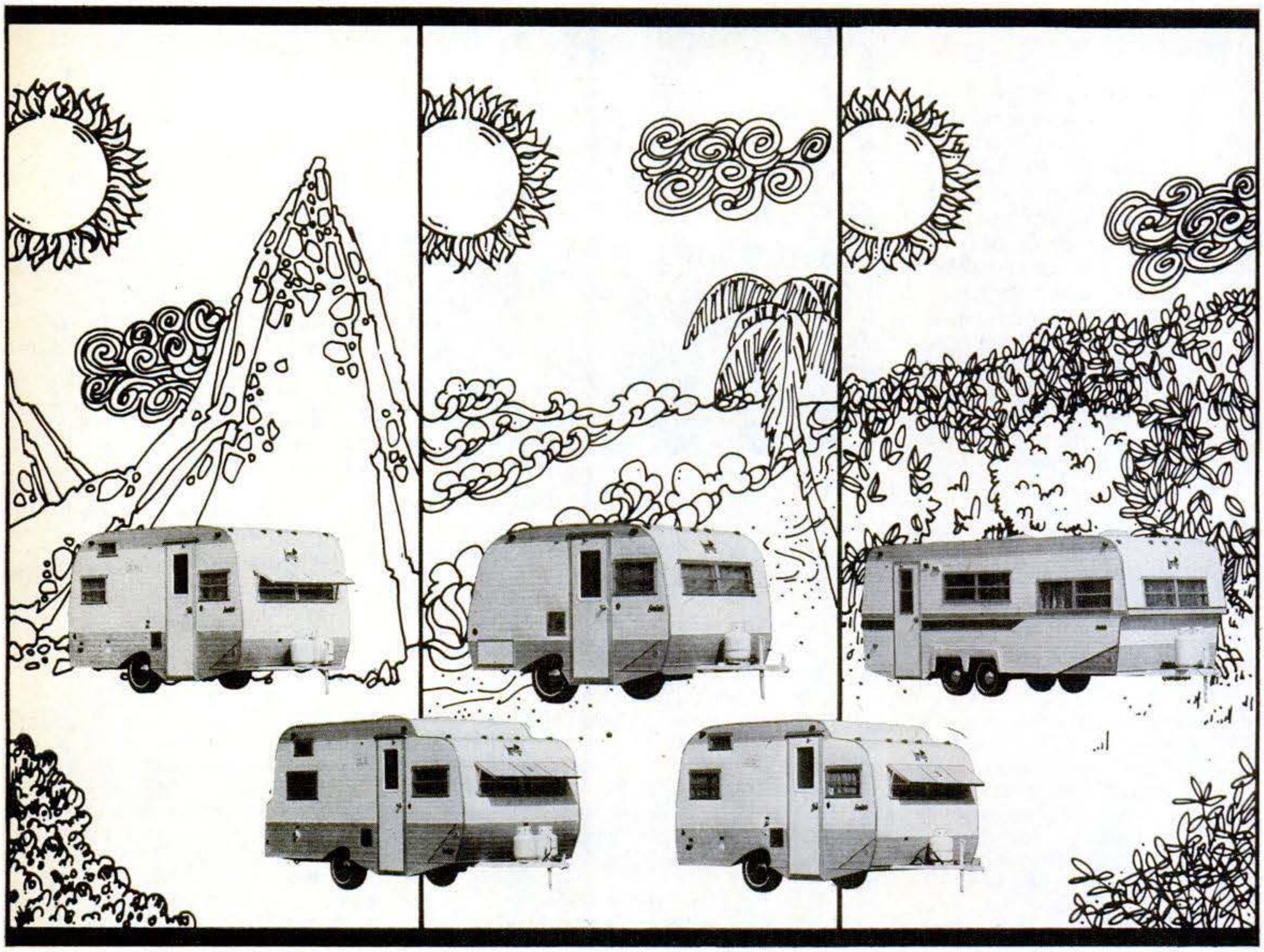

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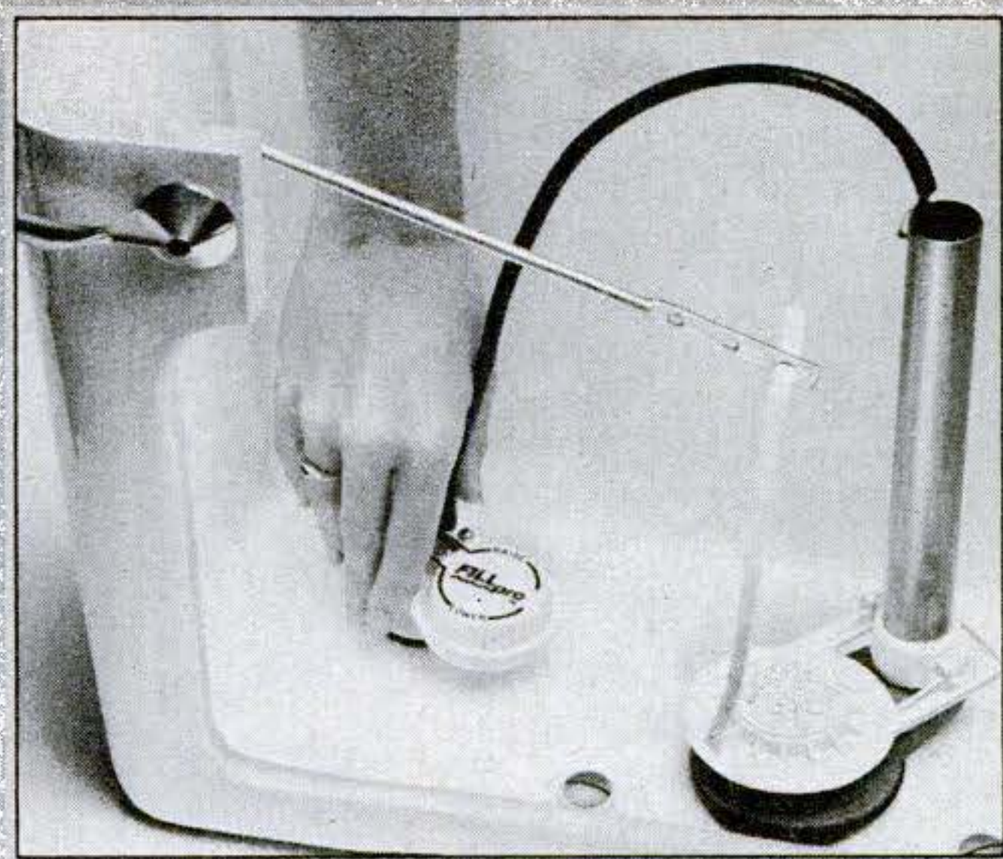

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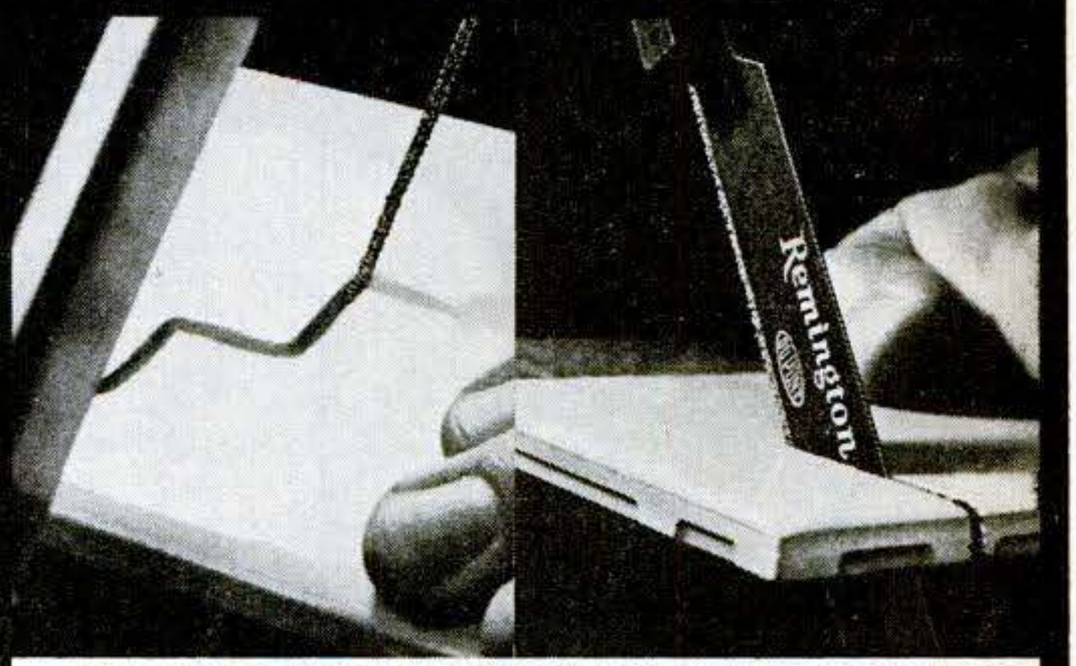
"Grit-Edge" blades trim tile with style.



Remington "Grit-Edge" rod saw and hacksaw blades make contour cuts in ceramic tile, snag-free cuts in high-pressure hose, cuts at any angle in hardened steel, space-age alloys and plenty of the other "unsawables".

Hundreds of tungsten carbide particles permanently bonded to "Grit-Edge" blades make them a match for materials conventional blades can't tackle.

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GRIT EDGE When ordinary blades can't cut it. Remington DUPONT

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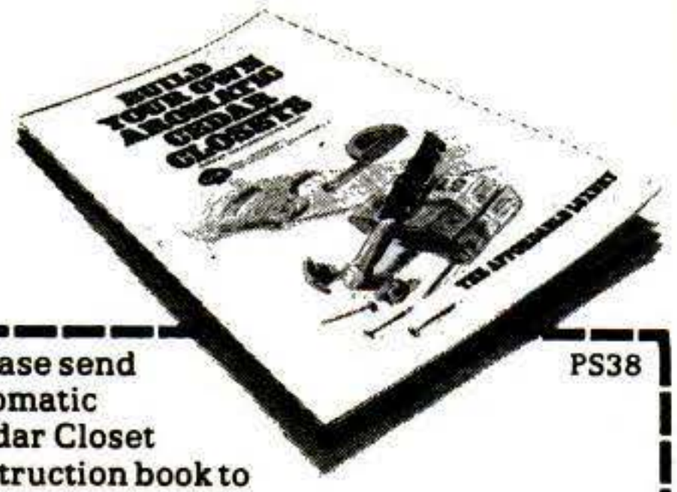

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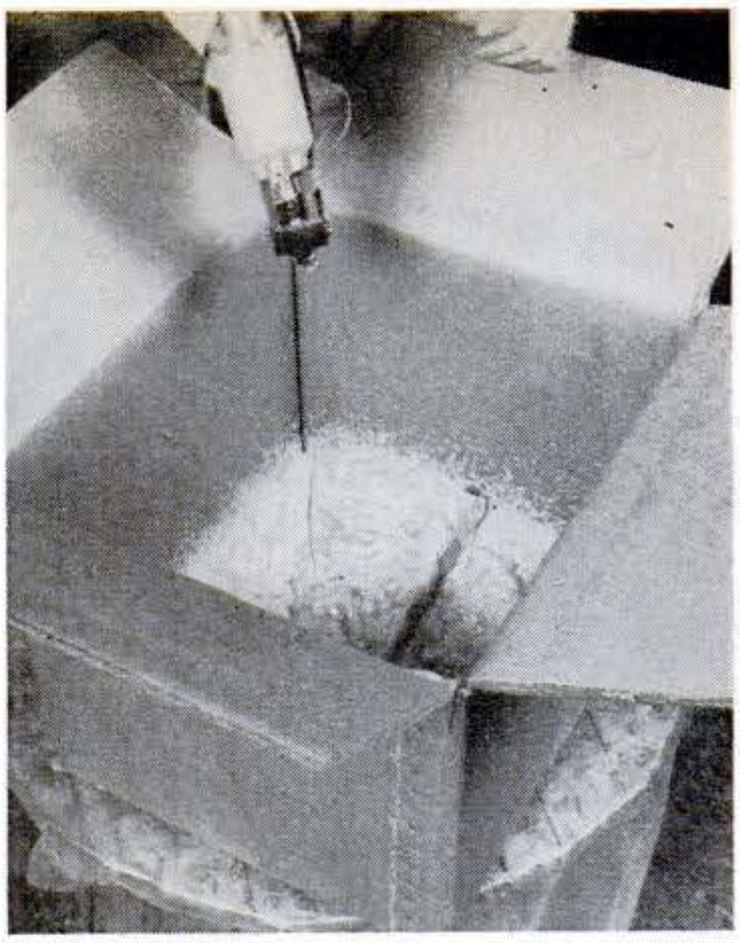

Shot of foam comes first, then a product is put in the carton. More foam is squirted in, the box is shut, and the foam expands to fill the whole carton.

Foam cocoon
for product protection

A new foam-in-place technology should make it easier for shippers to "handle with care." That's good news for industries whose increasingly delicate precision products demand shock-proof packaging.

With foam-in-place packaging, the product itself is the mold for the polyurethane foam. Squirted into a shipping carton, the foam expands to form a protective cocoon around the contents. The technology was first developed in the late 1940's. But quality-control problems existed due to improper chemical mixing, limited foam density, and dispenser clogging.

The new SolidiFoam system solves these problems, says the maker, Tri-Wall Containers (100 Crossways Park W., Woodbury, N.Y. 11797). The system consists of two 55-gallon tanks of chemicals, a dispenser gun, and a portable console with just four manual switches. Built-in rotary pumps are locked together with a common mechanical drive to make sure the chemicals, isocyanate and polyol resin, are mixed precisely. These ingredients blend together easily to produce a foam that has the flexible density needed for superior shock absorption. And the foam can't clog the gun—a mechanical purge automatically cleans the chamber after each use.

Tri-Wall SolidiFoam is so light (0.5 lb. per cu. ft.) that it will even lower shipping costs.—*Kate Griggs*

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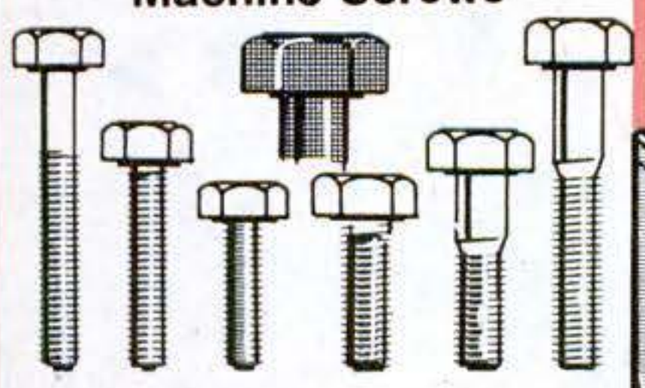

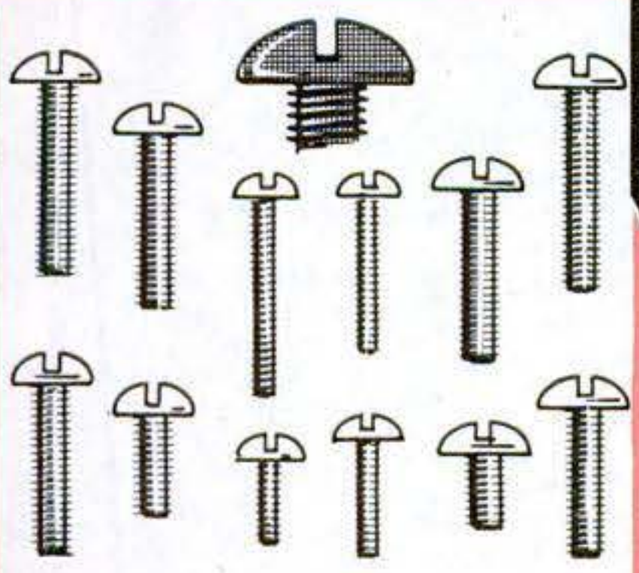

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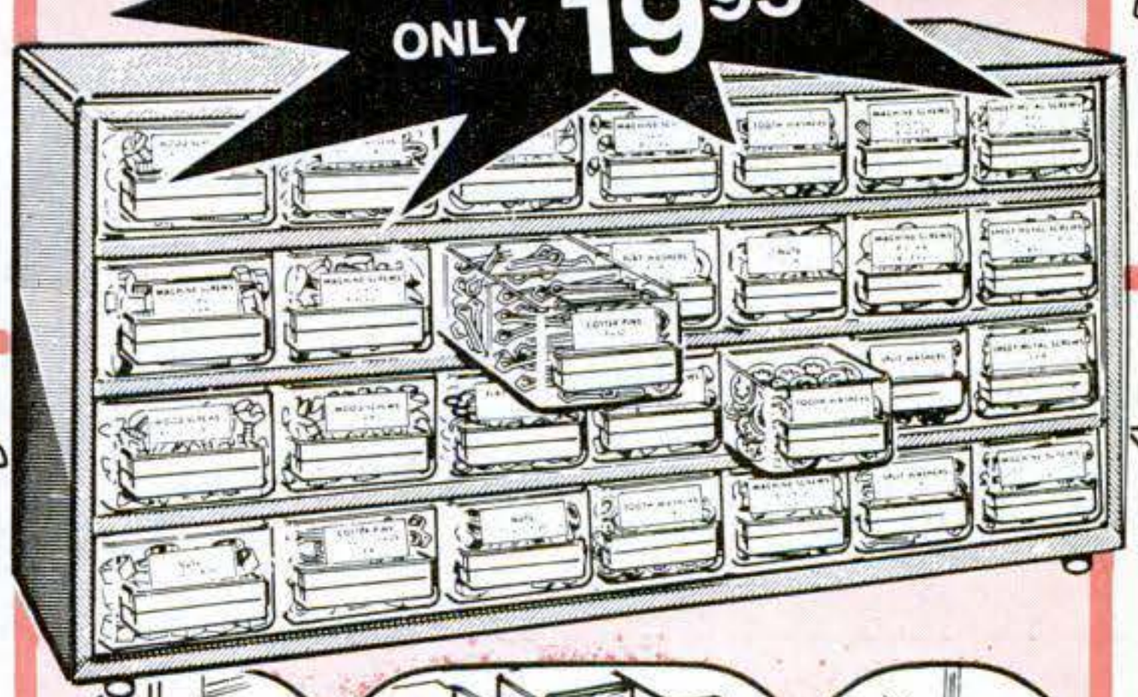

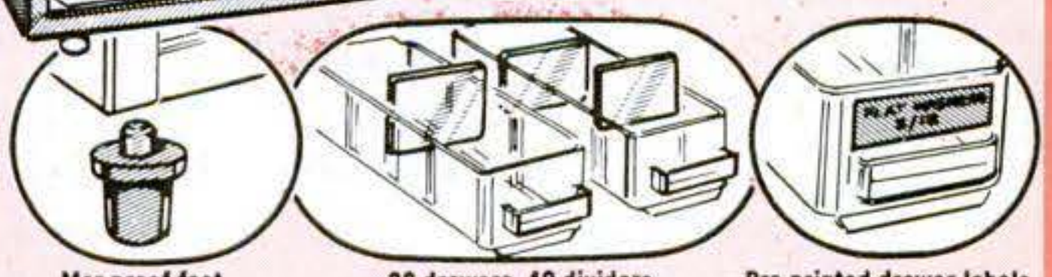

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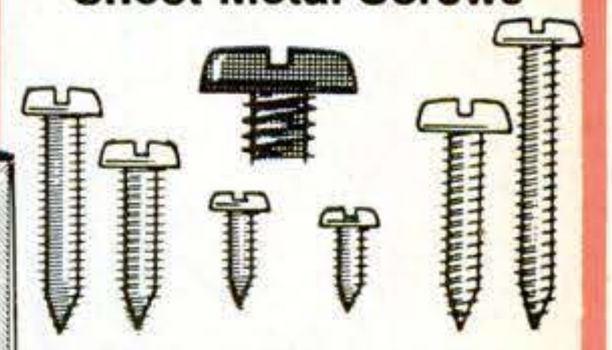

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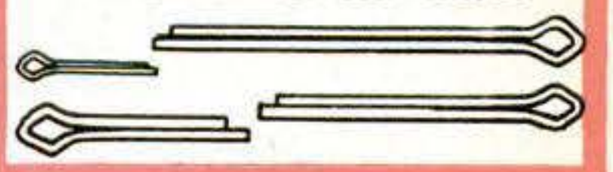

669
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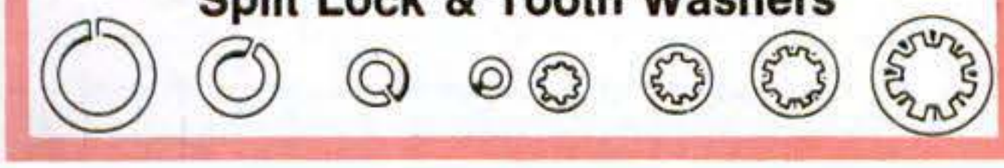

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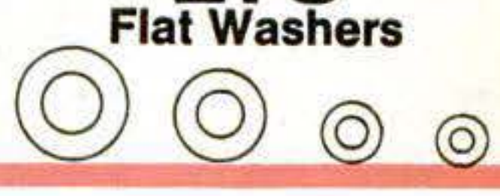

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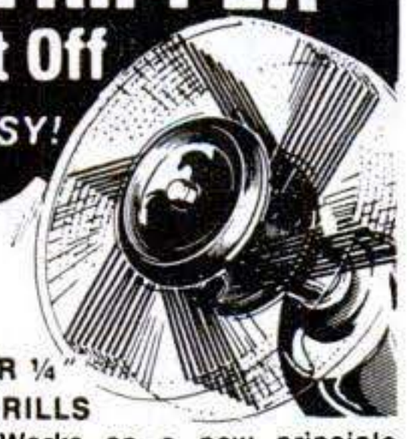

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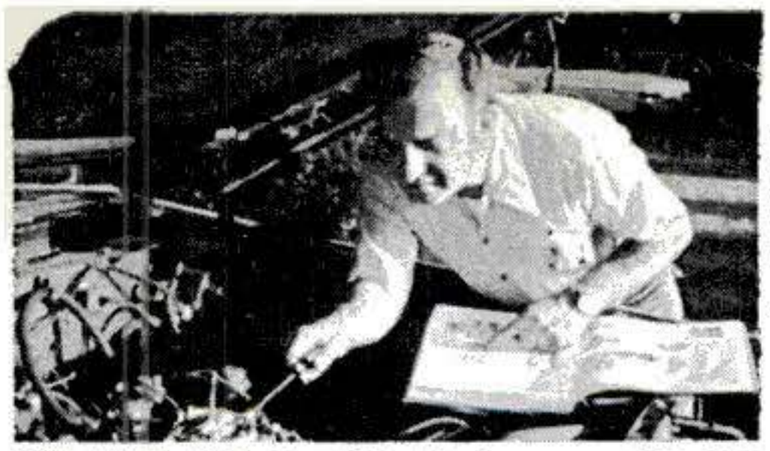

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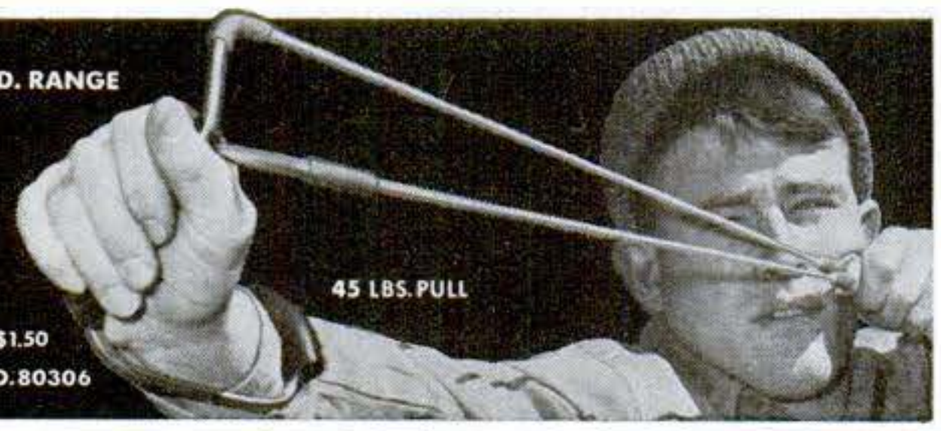

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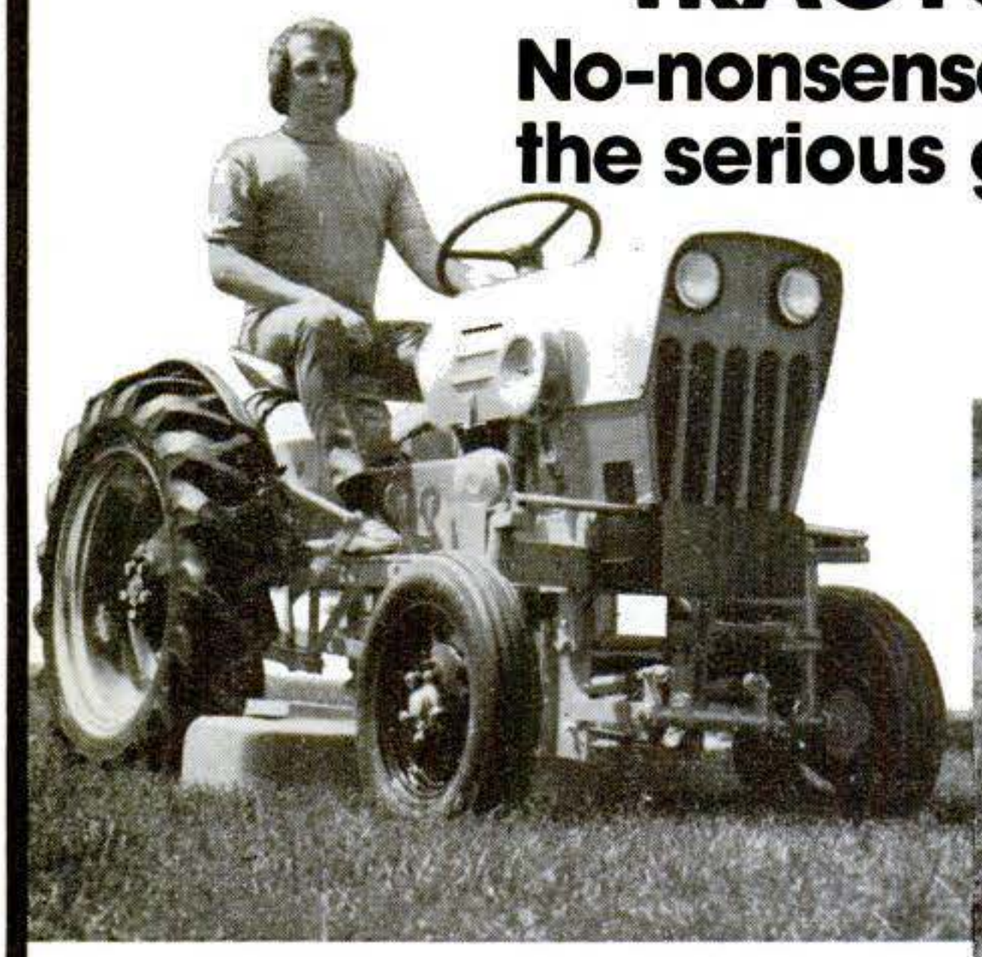

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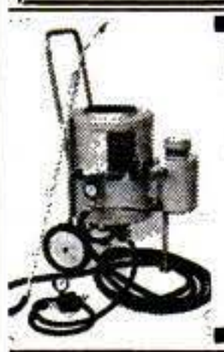

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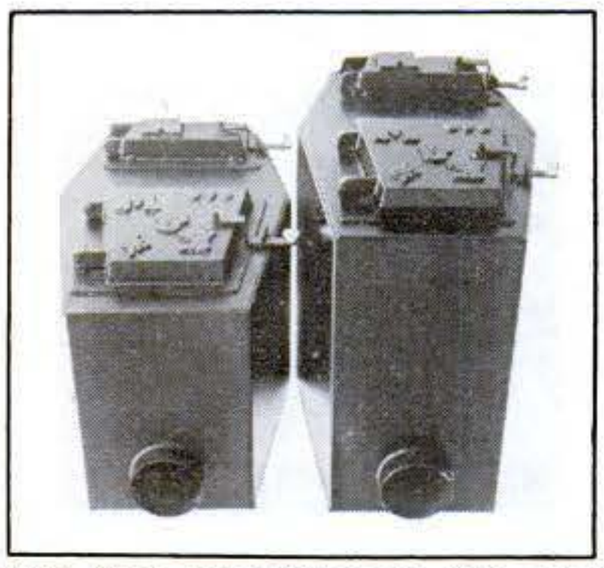

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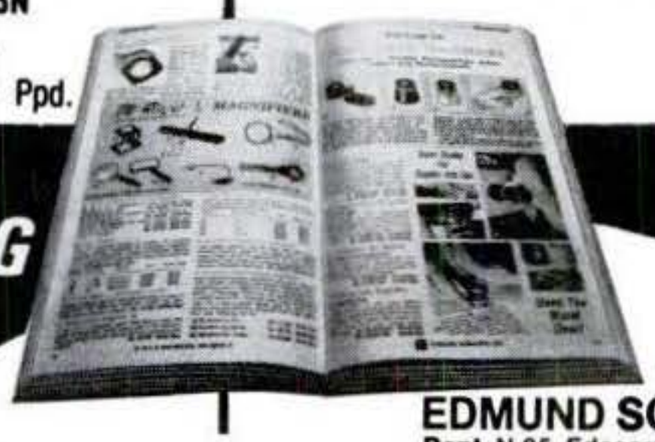

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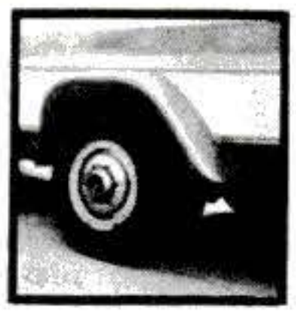

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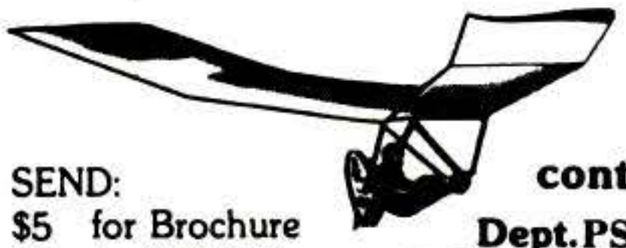

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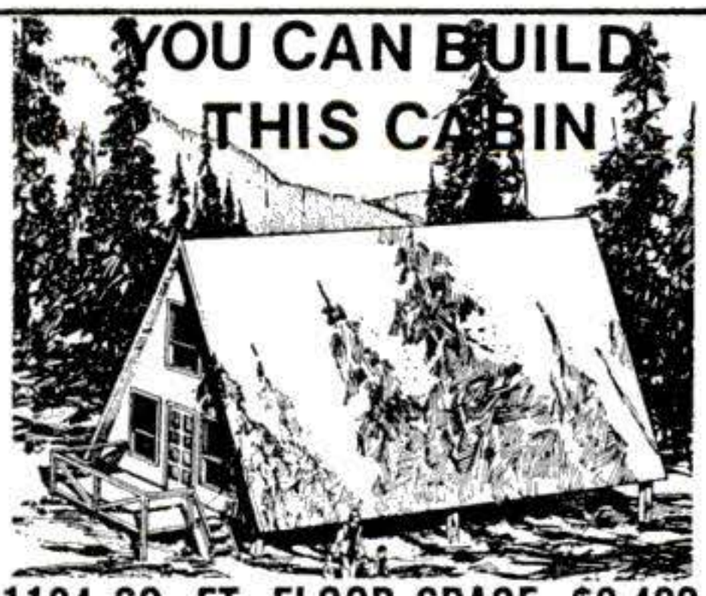

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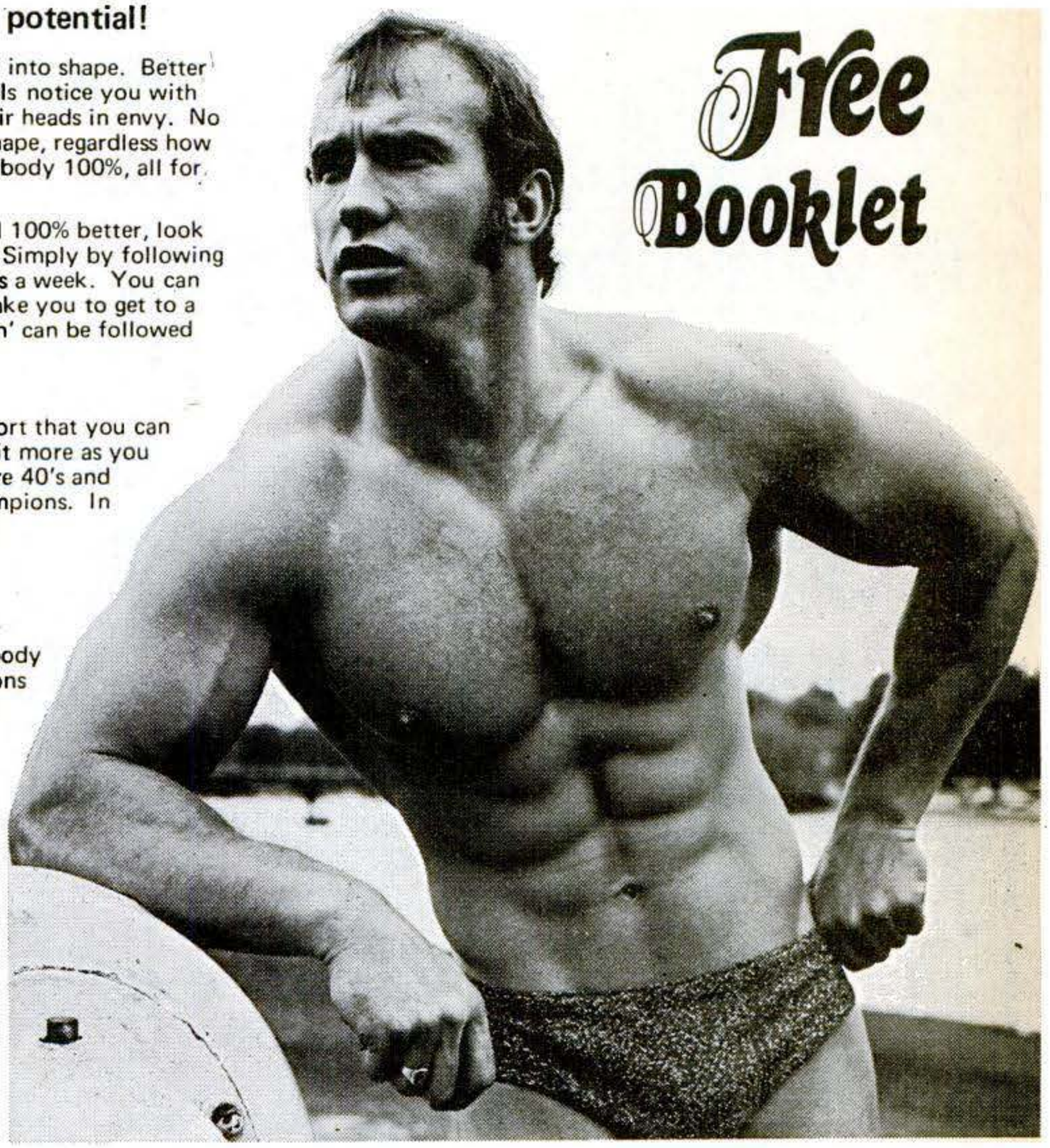

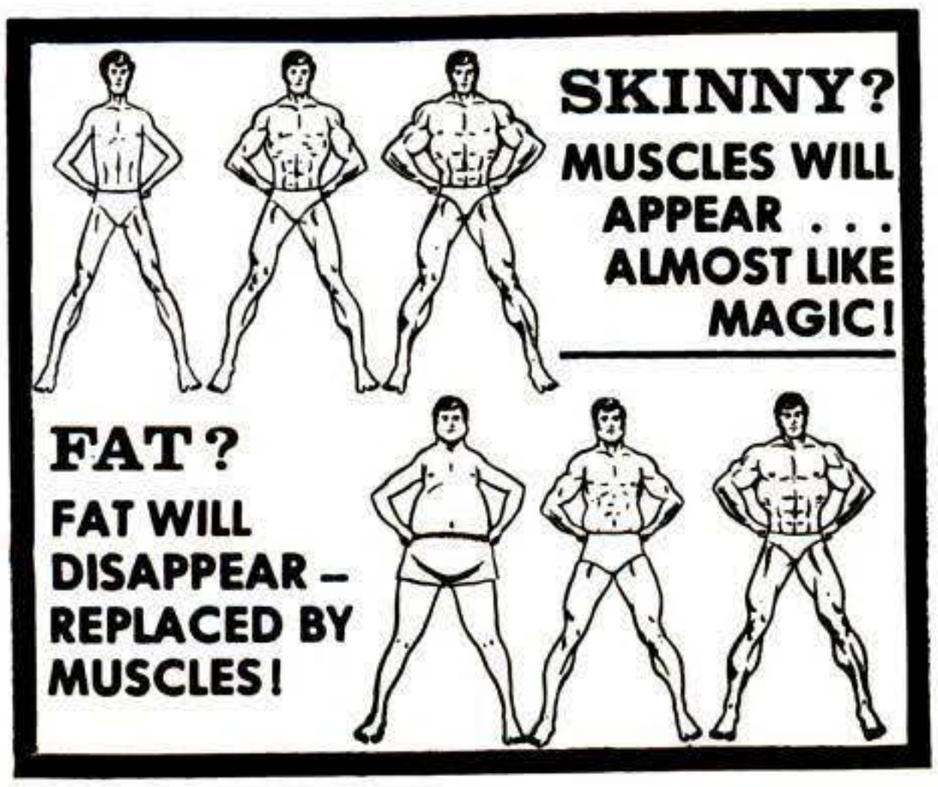

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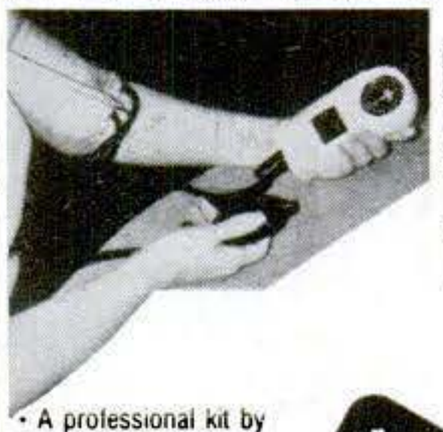

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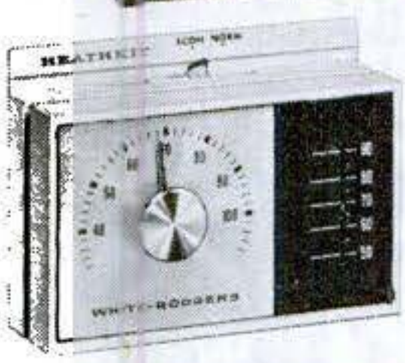

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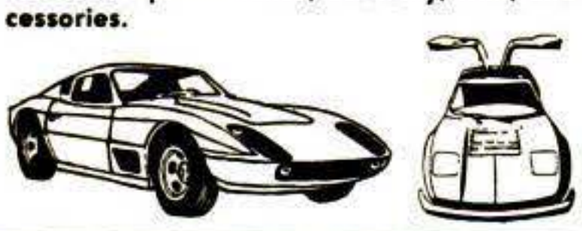

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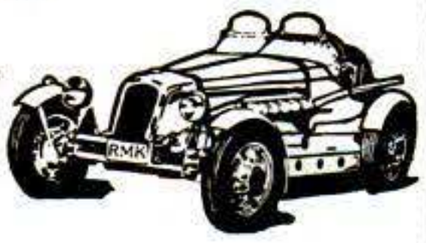

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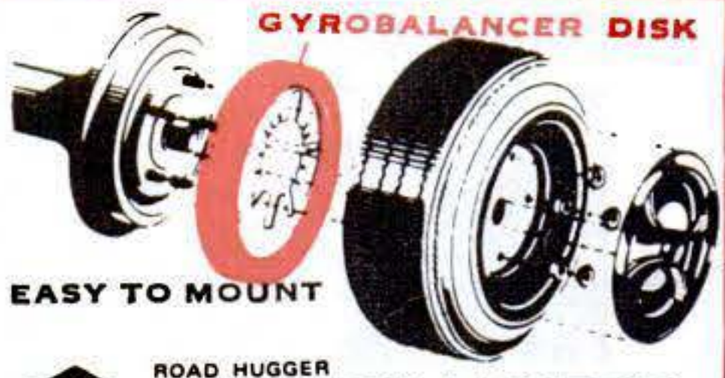

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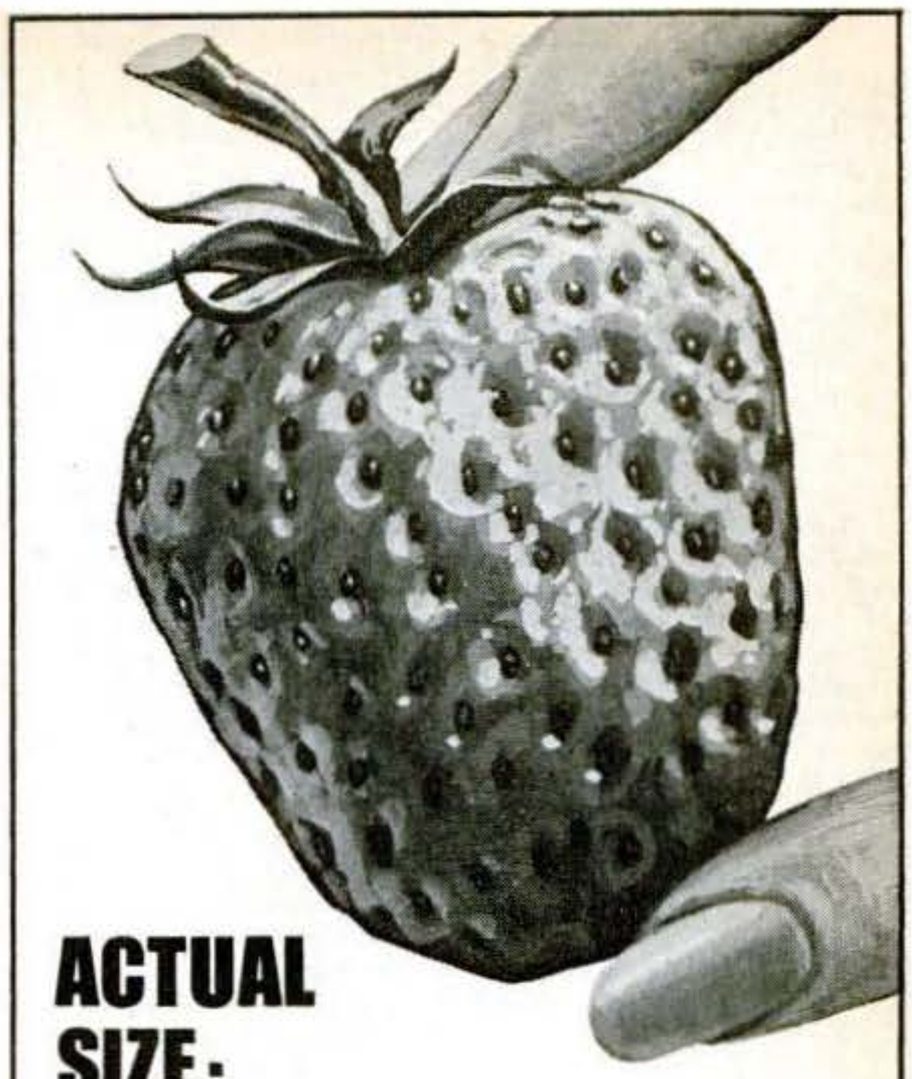

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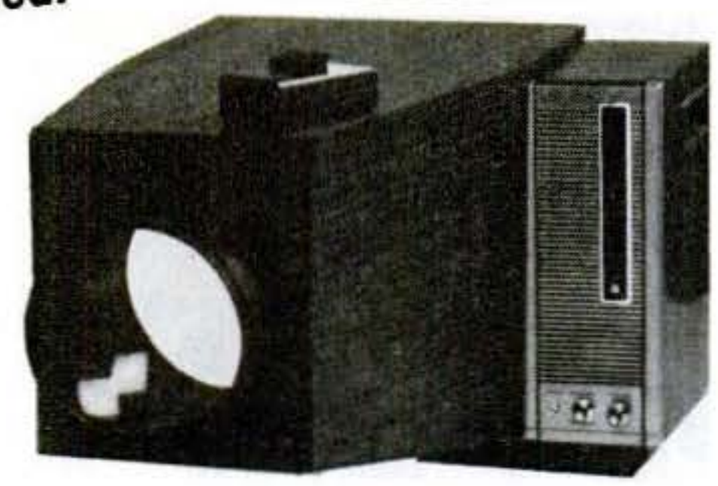

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The LIFESCREEN III projection system gives you all the enjoyment and excitement of the $4000 systems. Our new injection molded Tron-Ex lens (F/1.9) produces an amazing image that is over 3 times brighter than most nationally marketed big-screen TVs—including Sony. And the Tron-Ex delivers sharper focus to the screen edge for better overall clarity. Our light-enhancing Extron LS-50 screen is 6 times brighter than most movie screens, because the molded parabolic contour rejects extraneous light, concentrating a directionally selective TV image for clear, colorful viewing. The LIFESCREEN III plans provide exact dimensions to fit the 13" Toshiba (model C389), but they can be modified to fit most 12" to 19" portables. Pre-constructed LIFESCREEN III lens housings available for most TVs. Order the components catalog below. **COMPLETE PACKAGE $319**

LIFESCREEN II

The self-contained projection system that uses any transistor portable TV (12" to 19") . . . requires only 2 x 4 feet of floor space . . . fits neatly against any wall and lends its beauty to the decor of any room. **Includes Tron-Ex F/1.9 lens,** Extron LS-50 screen, two front surface mirrors, and building plans for the cabinet.

COMPLETE PACKAGE $369

LIFESCREEN I

The original independent projection system from Extron. Works with the Sharp 13" model 13A29 color TV or Sony 15" model KV1541R color TV. Can be used with any size screen. The LIFESCREEN I includes our new Tron-Ex F/1.9 lens, one front surface mirror, building plans for cabinet, and the LS-50 screen, 32" x 40"/50" diagonal.

COMPLETE PACKAGE $339

EXTRON GUARANTEES EVERYTHING: the professional quality, accuracy of description and availability of components described in this ad. After building your LIFESCREEN PROJECTION SYSTEM, if you are not satisfied for any reason, return all components to EXTRON for instant refund within 30 days.

LARGER SCREENS FOR THE LIFESCREEN I AND LIFESCREEN III SYSTEMS CAN BE ORDERED FROM OUR CATALOG.

Please send me the items checked below:

- ☐ ONE COMPLETE SET OF LIFESCREEN I PLANS $9.00
- ☐ ONE COMPLETE SET OF LIFESCREEN II PLANS $9.00
- ☐ ONE COMPLETE SET OF LIFESCREEN III PLANS $9.00
- ☐ **COMPLETE LIFESCREEN I PACKAGE $339.00**
- ☐ **COMPLETE LIFESCREEN II PACKAGE $369.00**
- ☐ **COMPLETE LIFESCREEN III PACKAGE $319.00**
- ☐ **EXTRON COMPONENTS CATALOG . (Applicable toward any purchase) $1.00**

All prices F.O.B. factory—Cal. residents add 6% sales tax

TOTAL $_____

EXTRON LIFESCREEN PROJECTION SYSTEMS
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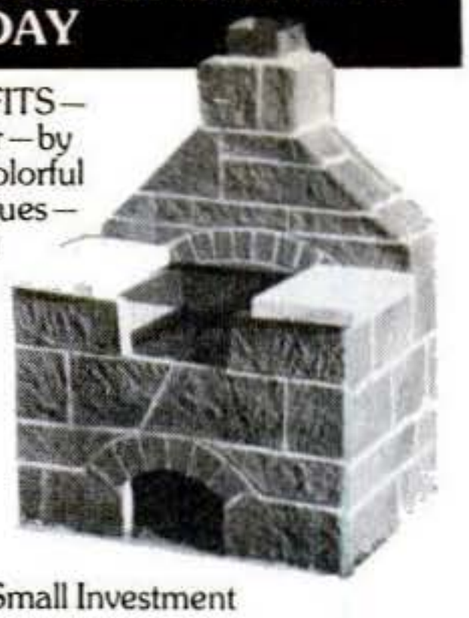

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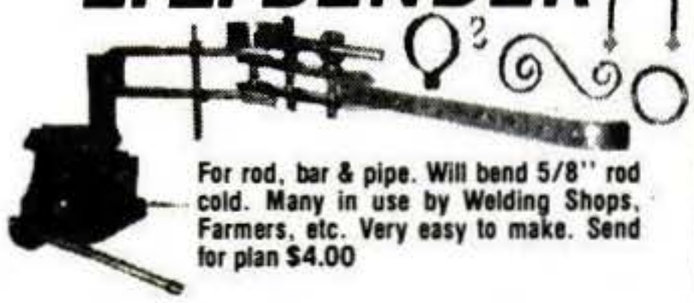

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Are we living in a time of government secrecy about the very nature of our planet? A massive coverup far greater than the censorship of U.F.O. reports? The United States lost 15 of the first 17 polar orbiting satellites it launched, then was successful when a direct shot over the north pole was avoided. Were those first 15 lost through the north polar opening to the earth's hollow interior? World famous polar explorer Admiral Richard E. Byrd had this to say about one of his polar explorations: "This is the most important expedition in the history of the world." If so, why haven't we heard more about such an important event? And he also said: "That area beyond the pole is the center of the great unknown." The Russians have said: "Exploration and research have shown that an enormous region of the earth's surface and correspondingly large realms of the unknown may be brought within the compass of human understanding in a very few years." Why do some birds and animals migrate north in the winter? Why does the Bible say "He stretcheth out the north over the empty place . . ." (Job 26:7). We now have a most amazing satellite photo that clearly shows what appears to be a 1400 mile wide opening (empty place?) in the north pole area, apparently taken at a rare time when not hidden by the normally obscurring cloud cover. Is this, the most controversial issue of our time, now proven by satellite photography? Whether you take this seriously or merely order a copy as a novel conversation piece, or collectors item, be prepared and forewarned! Its appearance is so striking, so disturbing, it will forever alter your concepts about the nature of this planet! We guarantee you must be satisfied, or simply return photo undamaged within ten days for full refund. Send only $3 plus 50¢ postage and handling to: NOVA PUBLICATIONS, Dept. PS, P.O. Box 9569, Minneapolis, Minnesota 55440.

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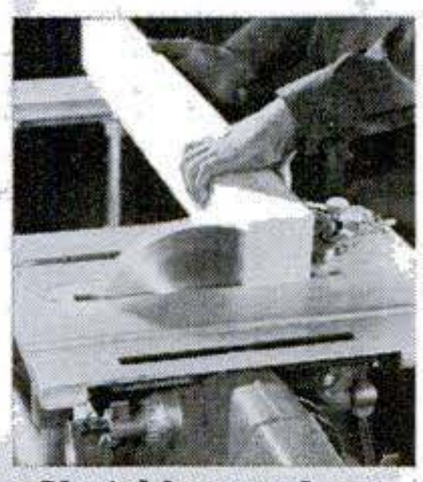
The Shopsmith Woodworking System.

A proven multi-use woodworking machine capable of performing as five of the most important power tools needed in the workshop: table saw, disc sander, boring machine, drill press, and lathe.

It's a simple yet systematic approach to woodworking excellence. Not just five tools in one, but *the one tool you need* to achieve professional results with minimum skill and experience.

Look. In less than a minute you can change from one tool to another:



1 as a 10" table saw with 3-1/4" depth of cut and 48" rip capacity for ripping, crosscutting, mitering, beveling, molding, tenoning, grooving, rabbeting and dadoing. Variable speed permits reduction of sawing speed for power sawing of hardwood—a Mark V exclusive.

Build your own furniture. Do home repairs and remodeling.

So simple to operate that within a very short time you'll be using your Mark V to build your own furniture and cabinets, make gifts, and do home repairs and remodeling. Projects you probably now pay someone else to do.

2 a big 16-1/2" swing capacity for spindle and taper turning or metal spinning. Will handle workpiece up to 34" in length. Exclusive speed dial permits speed changes without turning off motor.

Shopsmith fits your budget, your needs, your space, and your skill level.

- **economical**—costs less than you'd pay for a good quality table saw and drill press.
- **versatile**—exclusive features make possible unique setups for faster and accurate woodworking. Setups you can't duplicate even with a shop full of expensive commercial tools.
- **compact**—takes less space than it takes to store a bicycle (12 sq. ft.). You don't need a big workshop to have big workshop capability and precision.
- **easy to use**—beginner, week-end handyman, woodworking pro, the Mark V makes you look good . . . the skill and accuracy are built in the machine. All you do is flip the switch and guide the materials.

3 for sanding operations not possible on other sanders — like finishing edges to precise dimensions and sanding duplicate pieces to exact lengths. Use for bevel and angle sanding, jointing, dowel pointing.

Why pay for 5 tools, 5 motors, 5 spindles, 5 tables, and 5 benches?

The Shopsmith Mark V performs as five woodworking tools from a single power source: a powerful 13.5 amp motor develops 2 h.p. - enough power for the toughest job.

4 save time on every drilling operation with depth control dial, ready made jigs, and the right speed for every operation without belt changing. Use for drilling, mortising, routing and shaping.

More machine than you need?

If you're a beginner, maybe. But, following Shopsmith's simple system, you'll soon be doing things with wood you thought only pro's could do. The professional touches that separate the beginner from the craftsman. You can do it with Shopsmith. More than 300,000 satisfied Shopsmith Owners are the proof. Why not find out more?

5 perfect doweling in horizontal boring operations. Exclusive feed stop assures all holes will be exactly the same depth. Rack and pinion table for hairline settings.

TELL ME MORE!

To send for more information on Shopsmith's Simple System for Success in Woodworking,

mail your name and address to:

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WORLD'S STANDARD IN WOODWORKING EQUIPMENT

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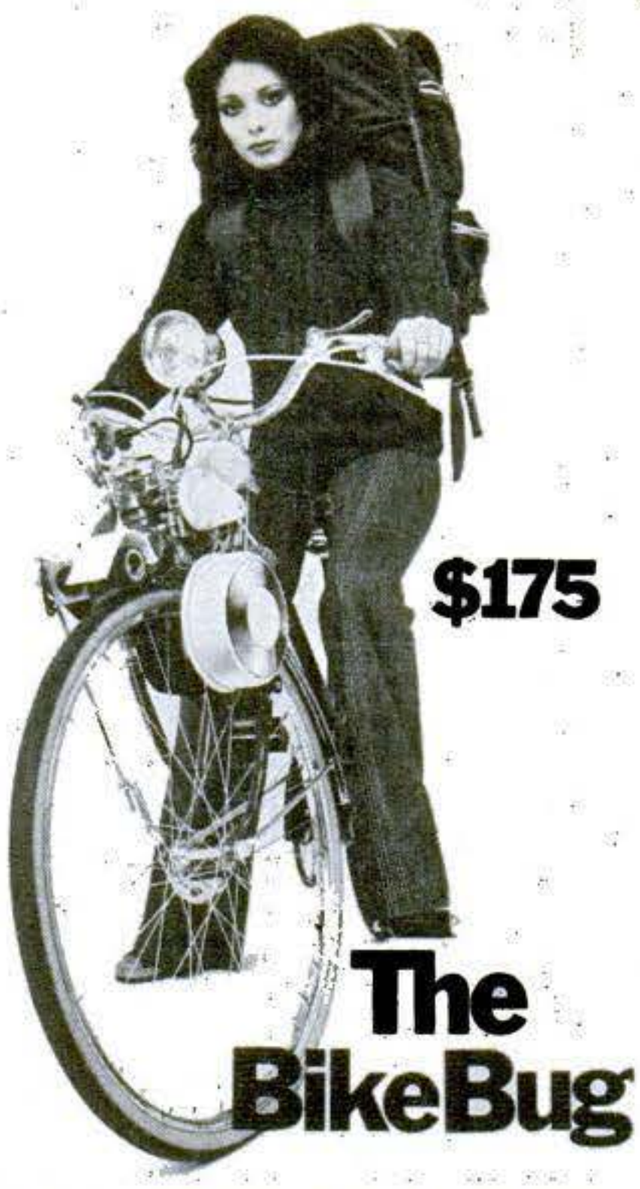
Auto Editor, Popular Mechanics

The Auto Editor of *Popular Mechanics Magazine* evaluated the BikeBug as an alternative to mopeds ... and his choice was the BikeBug! His two-page Product Report, (Dec. '77), was based solely on quality, design and performance. *Price* was *never* a consideration, *even though mopeds cost hundreds of dollars more* (Complete reprints with our free brochures).

The BikeBug engine and front-wheel-drive unit bolts in *minutes* to the front fork of any bike, from 10-speeders to adult tricycles. It runs up to 24 mph, gets 215 mpg, operates *quietly*, starts automatically, has a One-Year Warranty, *and allows normal pedaling, even with the engine running*.

For superior all-round performance, *regardless of price*, it's the BikeBug. And *Popular Mechanics* agrees.



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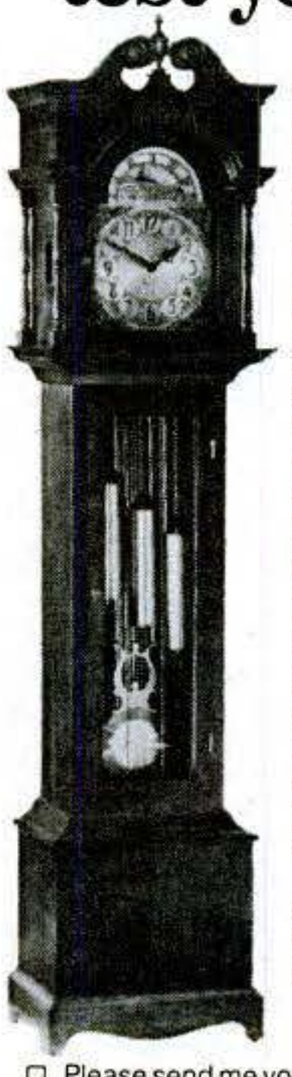

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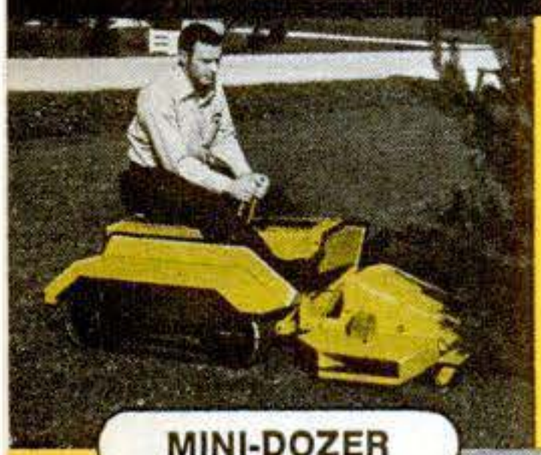

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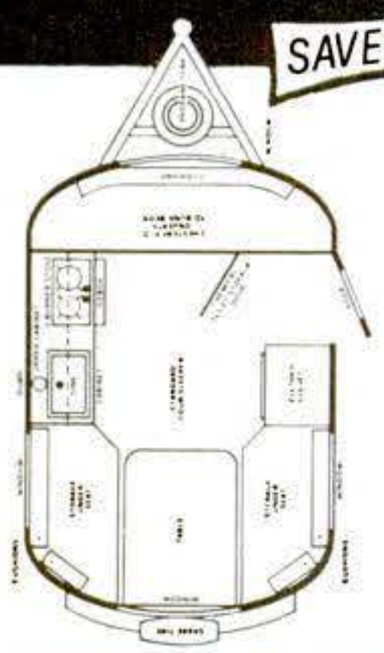

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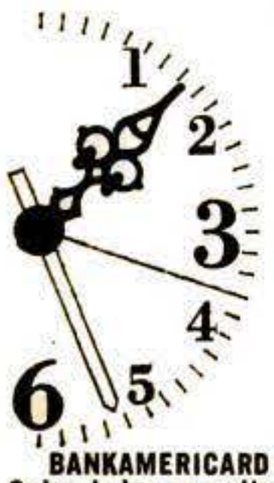

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HOW TO LIVE LIKE A MILLIONAIRE !

You Can Drive A Fancy Car And Have A Magnificent Home...All on An Ordinary Income!

Millionaires aren't a lot smarter than you. They simply learn to master the illusion of luxurious living in a society that depends on credit.

Many people are amazed to learn that in just a few years, my net worth has gone from zero to more than $1,000,000! But my wife, Sherri, and I can still remember what it was like to be over our heads in debt.

We lived in a crowded apartment. I was so up tight that I ate continually and wound up looking like a fat Santa Claus. In desperation I began to research the lives of successful millionaires like Rockefeller, Dupont and Getty.

I read book after book. And I interviewed successful executives everywhere. I learned that millionaires were not mental giants. They were just people who had learned the formulas for success and wealth.

So we started to put some of the millionaires' secrets to work. And in no time we were

- Driving a $14,000 car free
- Living in a beautiful home without a down payment
- Borrowing—vast amounts of money on my signature
- Getting VIP treatment everywhere
- Getting my name in the paper regularly
- Creating companies with the help of other people's money

People want to associate with a winner. People, including you and me, see a person with a Cadillac and fancy home and just naturally assume that he's wealthy.

I'll teach you to use this impression that you create to borrow all the money you want—even if you've been turned down for loans in the past. I know that you're certain that you have to have money to borrow money. But that's just not true. It will be like having your own magic wand.

If you just want to live the life of a millionaire, I will show you how to create that successful impression and get it all—the free luxury car, the fancy home and VIP treatment—the whole ball of wax.

Or if you want to go all the way and actually become a real millionaire, you can do that too. You will have to work at it. But everything you need to know will be right in front of you—line by line, step by step.

I will give you a complete blueprint to follow. And everything I tell you will be completely honest and legitimate.

As you begin to apply my techniques, you'll find yourself with the freedom to vacation in the world's finest resorts. Or to work only 4 days each week, as I do. But the most important thing you'll gain is priceless... that is the time with your family while you're still young enough to appreciate them.

Also, people who earn more money and live well, often become more attractive. Whether it is the visit to that special hair stylist or wearing designer clothing. If you begin to live the life of a millionaire—You will find yourself beginning to look the part.

People say that money can't buy you everything —love for instance. That's true. But I must tell you that successful people naturally attract members of the opposite sex. And if you are married, you know that money—or rather the lack of money, is the biggest cause of marital difficulties. As you achieve financial success and freedom, your love life will just naturally improve.

I did it, and so can you. In the last three years I've lived a dream. I've had more luxury, power and happiness than any man or woman could want in a lifetime.

My fully illustrated manual "How To Live Like A Millionaire On An Ordinary Income" will also teach you how to...

- Earn 17% on your money
- Become a political success
- Master the 10 principles of success
- Obtain a college degree without attending classes
- Get furnished executive suites free

My formulas do not require education. And they don't require money. You don't need a lucky horoscope or good fortune—Although God has been more than generous to me. You don't have to be a genius. All you need is enough brains to know what to look for and what to do. I'll show you all that.

I've laid out a complete map for you to follow.

Some people will read this letter and do nothing. They'll be suspicious, timid or just indicisive. That's okay because if everyone had enough courage to act, my role in life would be eliminated. And your success would be harder to achieve. I suggest you send for my material today, or forget about it. But do make a decision!

Today, I am the chairman of the board of three major corporations engaged in manufacturing, wholesaling and retailing, with sales of more than $100,000,000 per year. I have obtained my knowledge from the Wharton School, which is considered the finest business school in the world. But more importantly, my secrets have come from the "school of hard knocks" which is the best teacher of all.

I would like to share my formulas and ideas with you. Why? For two good reasons.

1. I expect to make a lot of money from these formulas.
2. There is nothing wrong in wanting to help people to live a happier, richer, more fulfilling life.

Copywright 1978 Steven West Inc.

BY Steven West, millionaire in 36 months

I, like most of you, have not had the help of daddy's money. So I would like to share with you what I have learned and all of my secrets for just $9.95. I am sure you will agree that this opportunity for success and financial peace of mind is the greatest bargain you can obtain.

For those who want more in life than a three-year old Chevrolet and warmed over TV dinners, I think the following offer is one you cannot refuse.

I, Steven West, personally guarantee to refund your money within one year, if this material is not all that I say it is, or doesn't satisfy you completely.

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Or just put the words "Live Like A Millionaire" on any size piece of paper and send it to Steven West, Inc., Suite 899, 6 New Avenue, Wyandanch, New York 11798. Be sure to enclose a check or money order for $9.95 plus $.95¢ for postage and handling, and give us your name and address. If you prefer, you can charge it to Master Charge or BankAmericard VISA. Just send me your account number and expiration date. By the way, if you feel uncomfortable sending me a check, feel free to post date it 30 days.

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P.S. Here's what people have to say.

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Achieving real success requires a successful image. Steven West is the master image builder."

Ronald DeFusco, President Atlantic-Spartan Department Stores.

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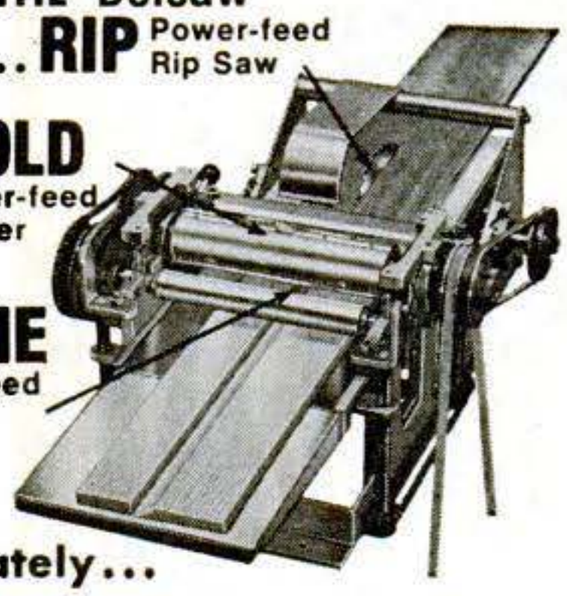

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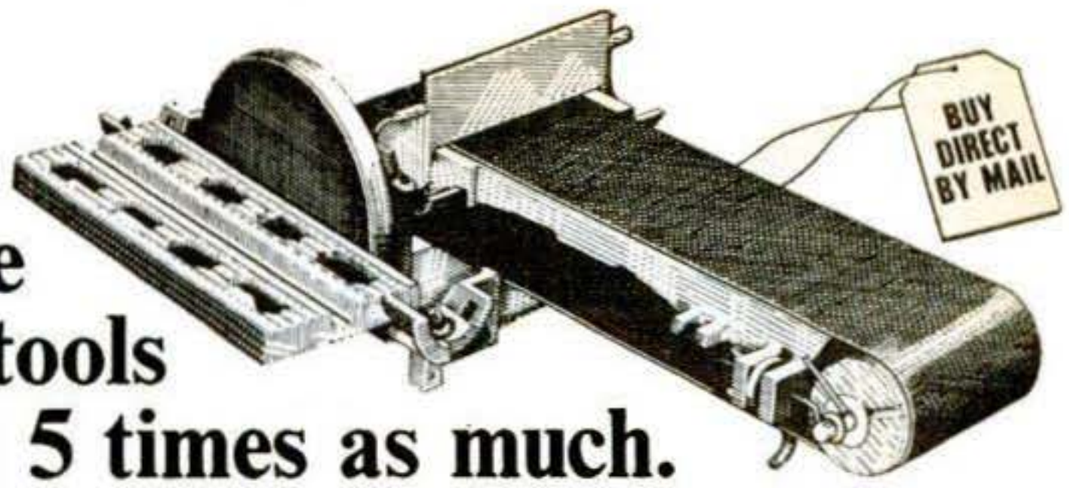

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We skipped the chrome to save you money... but we did not skip anything on performance. Actually, we skipped more than just chrome, we cut out every costly frill that wasn't absolutely needed.

Our tools are not exactly flashy. We are the first to admit it. But in articles covering test results on AMT tools, written by leading publications such as Popular Science, our tools have been praised over and over again. In spite of their low prices, our tools are full scale and offer full performance and precision.

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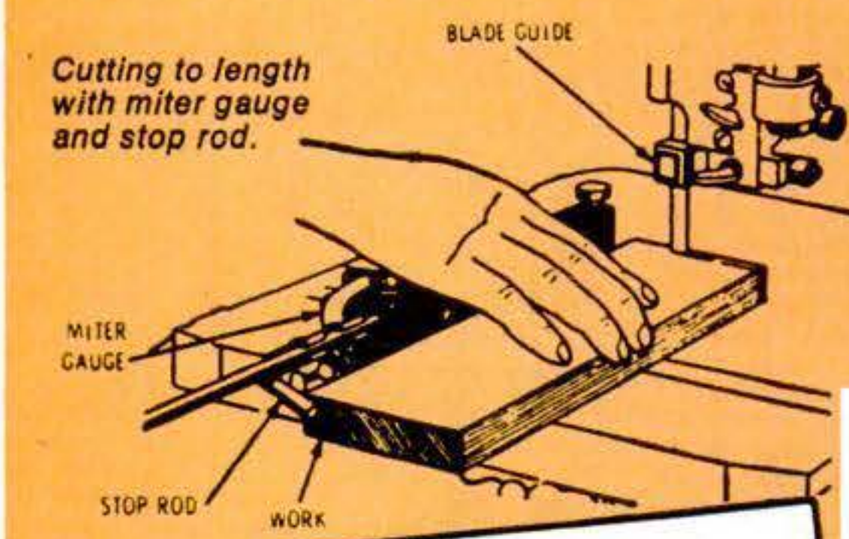

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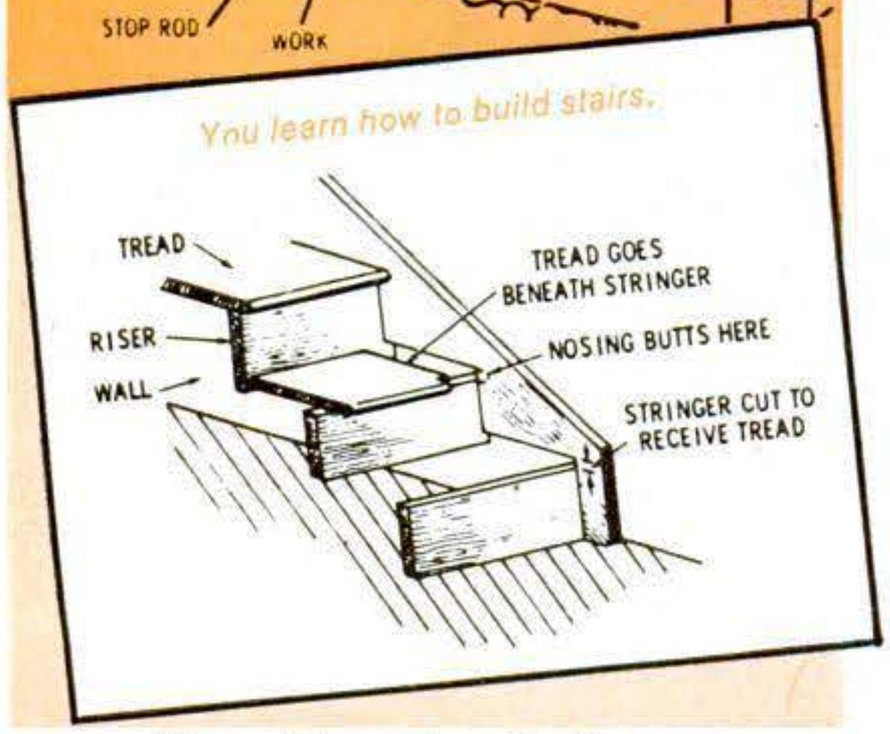

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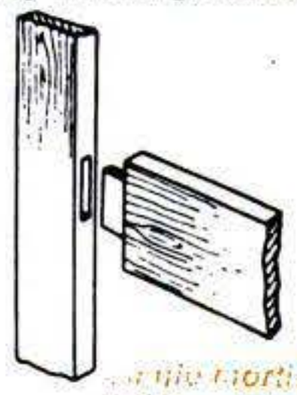

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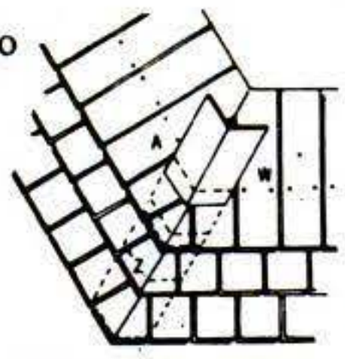

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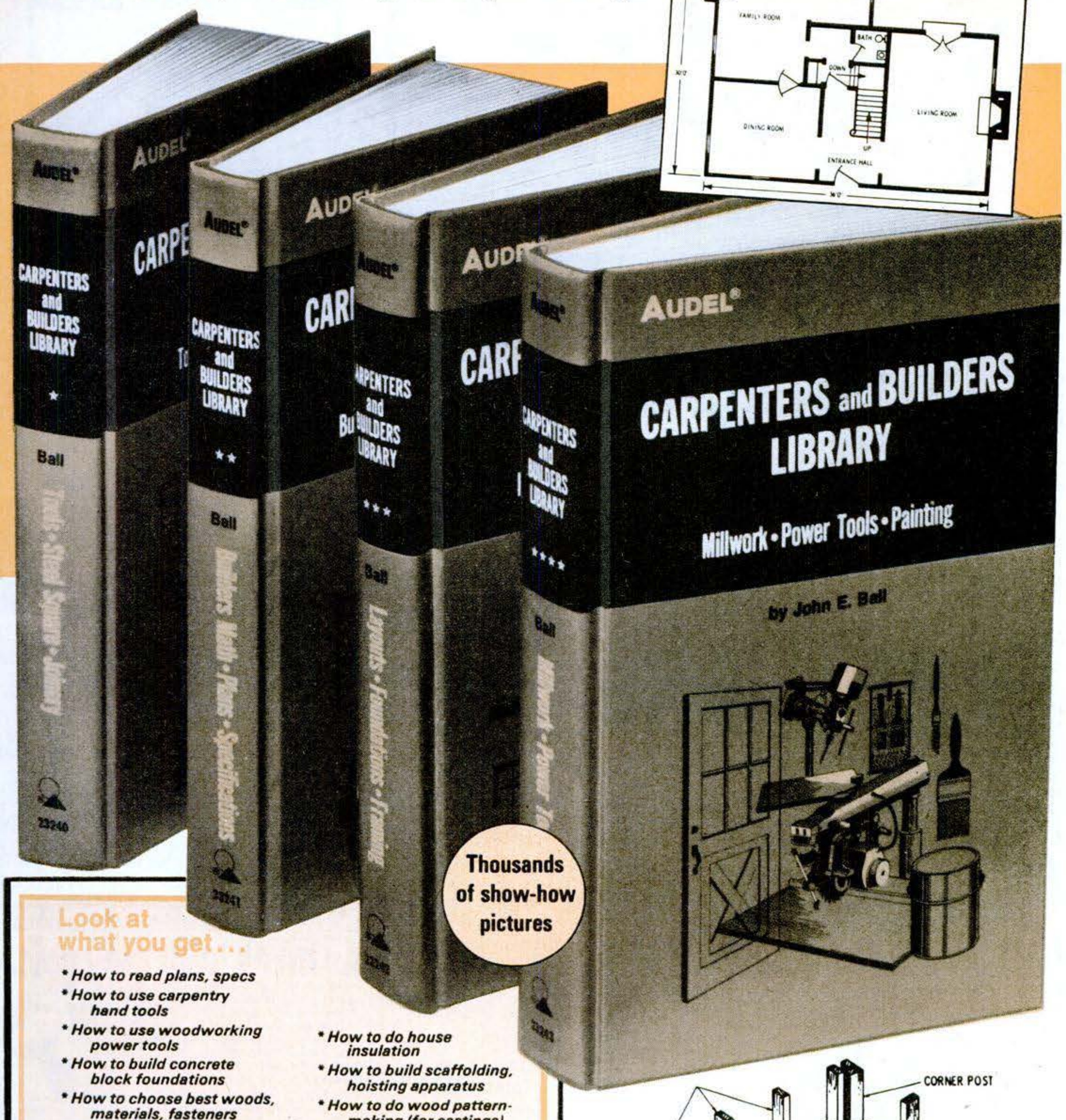

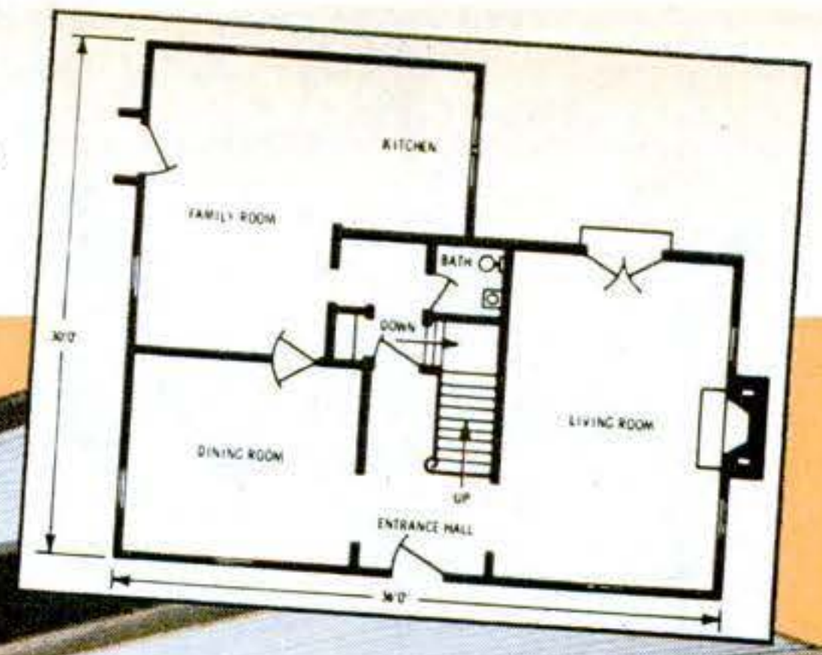

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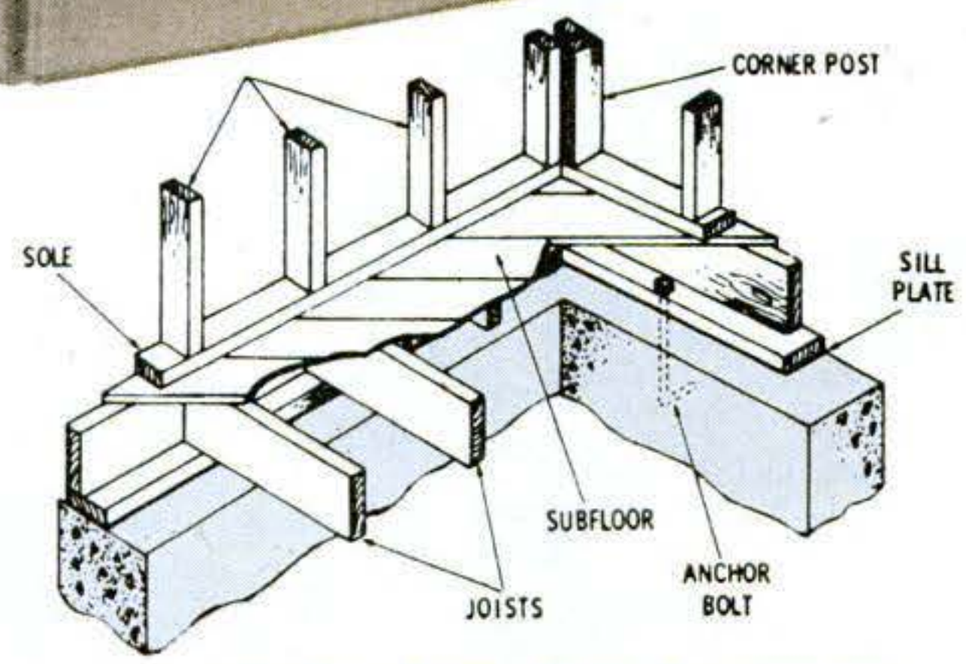

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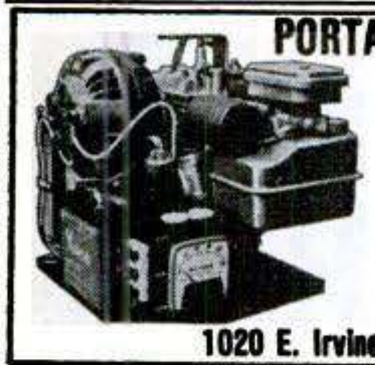

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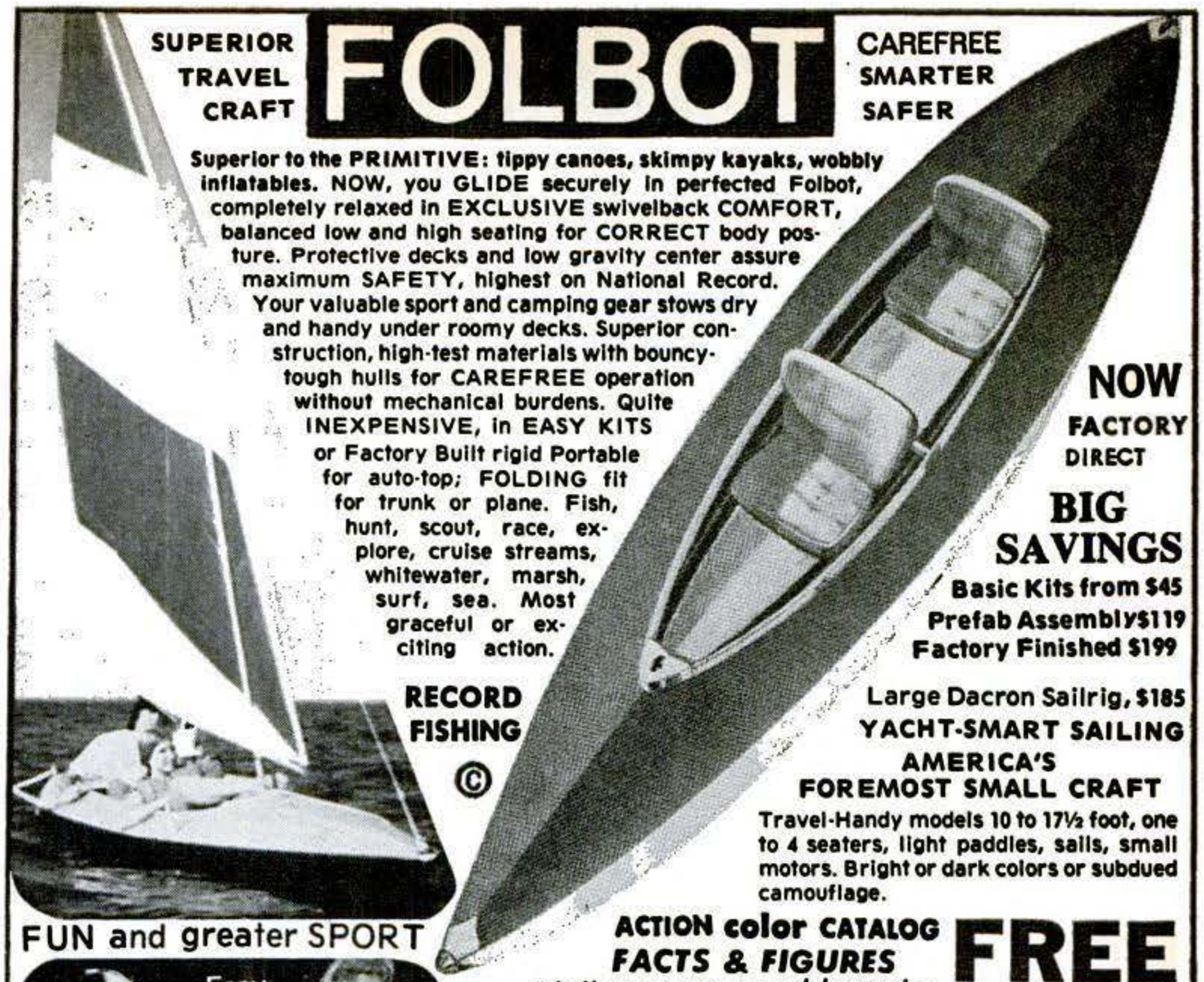

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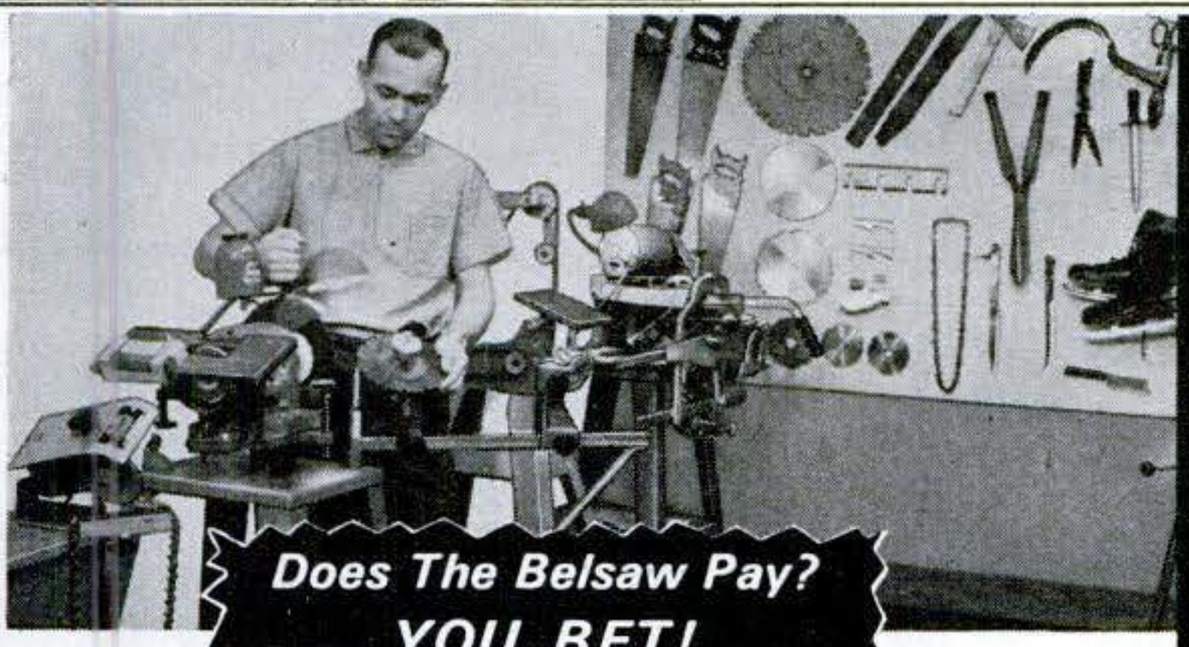

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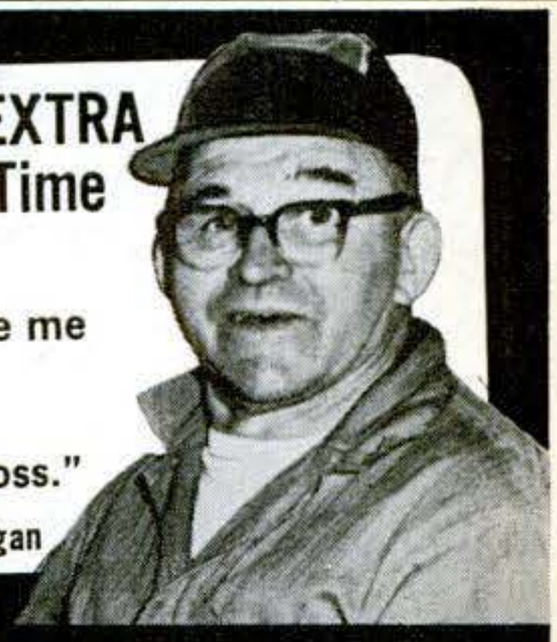

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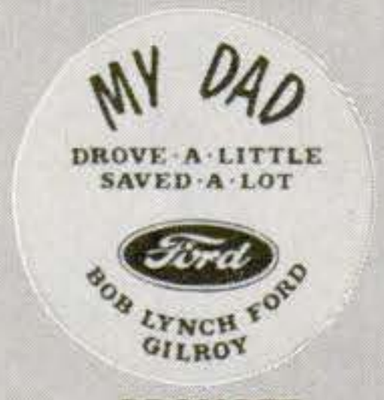

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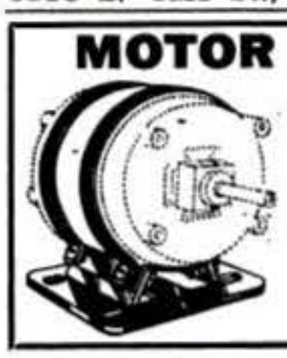

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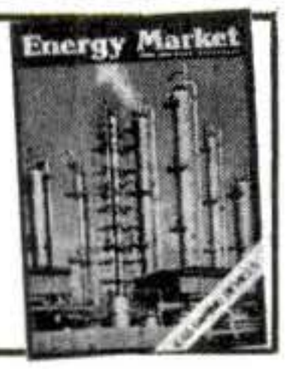

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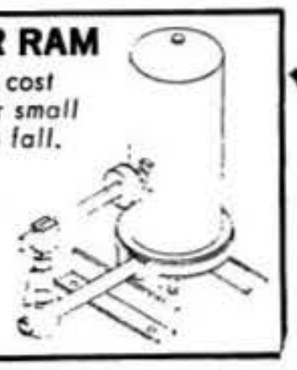

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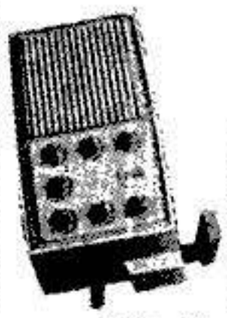

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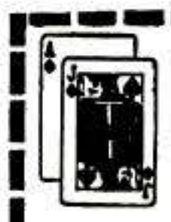

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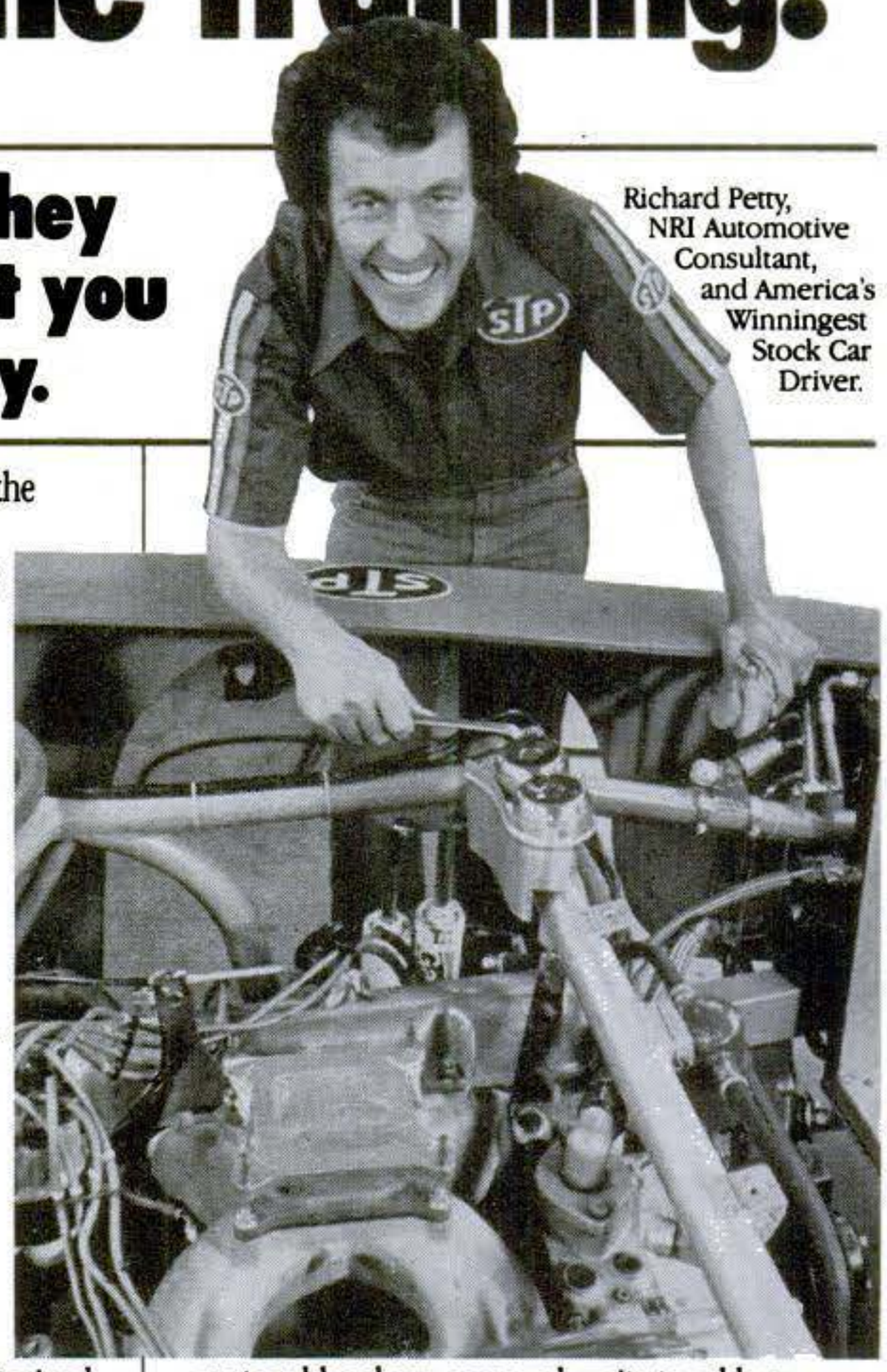

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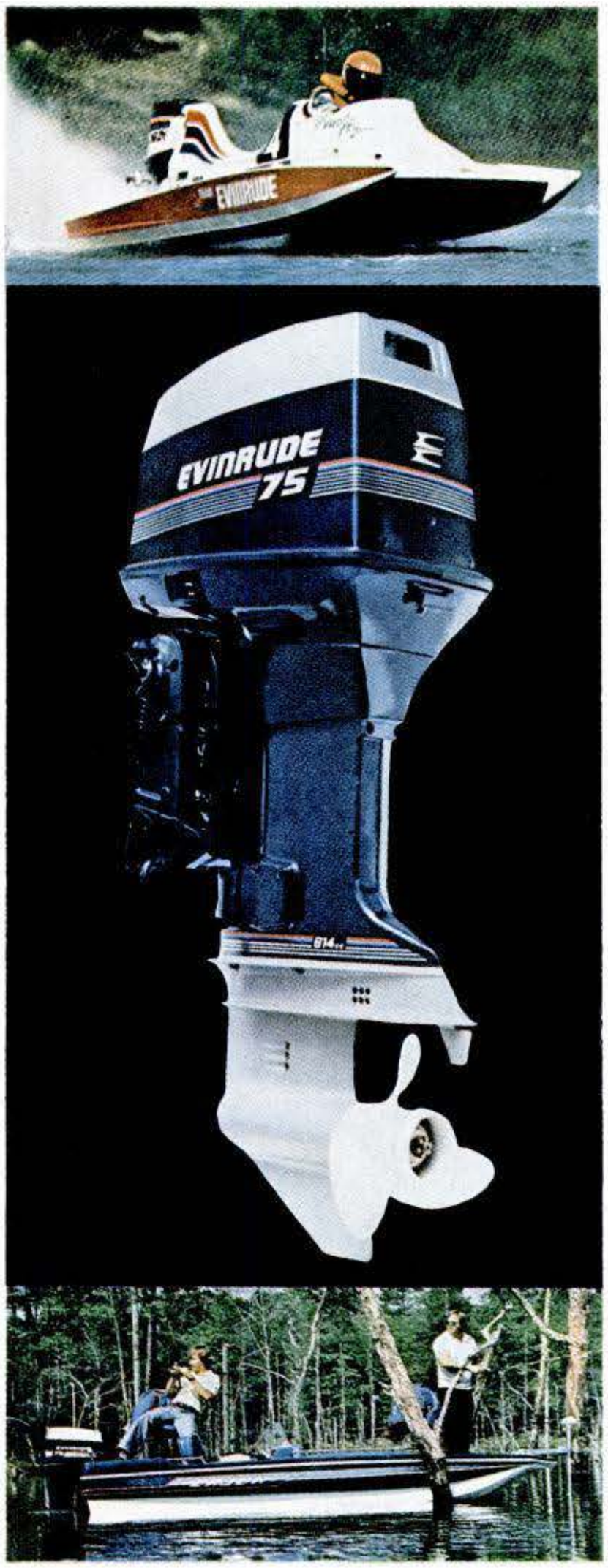

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